

Vignettes from the History of Plant Morphology

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I. AGNES ARBER: MORPHOLOGY TO METAPHYSICS AND MYSTICISM



"The leaf is a partial shoot . . . which has an inherent urge towards the development of whole shoot characters." That strange sounding statement was first published over 50 years ago by an eminent plant morphologist, Agnes Arber (1941). What brought her to write such a statement is the subject of this first chapter.

As a graduate student in botany at the University of Michigan, while browsing the library one day, I came across a book with the unusual title *The Natural Philosophy of Plant Form*, by Agnes Arber (1950). It seemed to deviate from the objective, empirical science in which I was being trained. A few years later (1954), Arber published another book, *The Mind and the Eye*, which strayed even further from the path of pure science. Finally, in 1957, just three years before she died, her last book, *The Manifold and the One*, appeared. Her opus ultimus was rejected by Cambridge University Press, which had published her previous books. Perhaps it had wandered too far from the realm of science.

Agnes Arber (néé Robertson) was born on 23 February 1879, the daughter of Henry Robert Robertson and Agnes Lucy Turner. She grew up in an environment of intellectual stimulation. Her father was an artist, her sister Janet became an artist, and her brother Donald S. Robertson became Regius Professor of Greek at Trinity College, Cambridge.

Agnes entered University College London in 1897, obtained a B. Sc. degree with First Class Honours in 1899, and went on to [Newnham College](#), Cambridge, on scholarship. She passed Part I of the Natural Science Tripos [1] in 1901, and Part II (botany and geology) in 1902, achieving First Class Honours. In 1902 she became research associate to Ethel Sargent (who had a private lab) and in 1903 returned to University College, London, to do research and teaching with a Quain Studentship in Biology, 1903-1908, and a Lectureship in Botany, 1908-1909. In 1905 the University of London awarded her a degree of D. Sc. for her research on *Torreya Californica*.

While developing her ability as a plant anatomist and morphologist, aided by such people as F. W. Oliver, Arthur Tansley, A. C. Seward, and William Bateson, Agnes Arber continued her acquaintanceship with the arts. Art training from her father aided her facility in observing and illustrating cellular detail, which enhanced her scientific books and papers. While a student at North London Collegiate School for Girls, she was introduced to the work of Goethe by Miss Edith Aitken, who taught botany there. She remained interested in Goethe throughout her life. Another early influence that combined art and botany was a well-illustrated herbal which she had the opportunity to see as a 15-year-old because her father was asked to evaluate it for sale (Muriel Arber, interview).

From the beginning of her work, Arber produced papers on the anatomy (1903, "Notes on the anatomy of *Macrozamia heteromeria* Moore") and morphology (1904, "Spore formation in *Torreya Californica*") of plants, along with historical papers (1906, "Nehemiah Grew and the study of plant anatomy") and philosophical (1913, "The botanical philosophy of Guy de la Brosse: a study in seventeenth century thought").

In 1909 Agnes Robertson married E. A. Newell Arber, a paleobotanist at Trinity College, Cambridge. They rented a house at 52 Huntingdon Road where Agnes Arber lived for the next fifty-two years, until her death in 1960. Their only child, daughter Muriel Arber, was born in 1913. Newell Arber died when Muriel was five, and Agnes remained a widow, raising her daughter alone.

Agnes Arber became associated with Newnham College, one of only two women's colleges at Cambridge [2] and used the facilities of the Balfour Lab at Newnham for her research. Although women could attend lectures in the university, they could not use the labs there until after World War I.

In 1927, Newnham College closed the Balfour Lab and Arber, looking for research facilities, remodeled a room in her flat at 52 Huntingdon Road into a lab. It had been a servant's room over the kitchen but was vacant because the live-in maid had married. This was advantageous, for Arber could go there and work at any time. It also enabled her to have "a room of her own." She had shared the Balfour Lab with [Edith R. Saunders](#). In an address to the students at Girton in 1926, she said: "The concentration of mind necessary for independent thought is far

more easily achieved in a place where one can get a generous measure of solitude than in a populous laboratory where people are incessantly running in and out, and in Ethel Sargent's words 'Independence is the essence of research'" (Stearn 1960). [3]

Arber chose to live humbly rather than earn money teaching. Thus she could devote her time and energy to her own research. She was throughout her life passionately interested in what she was doing. "She wanted to do it more than anything" (Muriel Arber, interview).

In order to devote her life to a seeking for truth and understanding, she kept domestic and social involvement to a minimum. W. T. Stearn (1960) wrote, "Mrs. Arber never sought publicity and was reputed a recluse: in fact, she was a genial and gracious person whose kindness and friendship will be gratefully remembered by the students of botany she helped and encouraged." And, according to Henry N. Andrews (1980) "Agnes Arber was one of the kindest people I have ever met and one of Britain's great botanists."

She managed to write more than eighty scientific articles plus numerous historical and philosophical articles, book reviews, and books between 1903 and 1960. The last article involving original scientific research was published in 1942. World War II and poor health interfered, and she spent the last part of her life exclusively on her historical and philosophical writings.

Agnes Arber's first book, *Herbals; Their Origin and Evolution: a Chapter in the History of Botany: 1470 to 1670* (1912), was written at the encouragement of A. C. Steward. It became a classic and a second edition appeared in 1938. In it she nicely combined her interests in plants, art, and the history of botany. Her next three books: *Water Plants; a Study of Aquatic Angiosperms* (1920); *Monocotyledons; a Morphological Study* (1925); and *The Gramineae; a Study of Cereal, Bamboo, and Grass* (1934), were all valuable additions to botanical literature, and all were reprinted after her death.

She was named a Fellow of the Royal Society in 1948, the third woman to achieve this honor, and awarded the Linnean Medal by the Linnean Society, the first woman so recognized. Thus, her reputation as a plant morphologist and anatomist was well established when *The Natural Philosophy of Plant Form* was published in 1950. In the preface to this book, Arber wrote:

In the present study, I have tried to express certain general ideas, which have gradually disengaged themselves in my mind, in the course of a lifetime's concern with the morphology of flowering plants, both as it is understood today, and in its historical development from the time of Aristotle onwards. I began by thinking of this subject quite simply as a branch of natural science, but I have come finally to feel that it reaches its fullest reality in the region of natural philosophy, where it converges upon metaphysics. . . . The thread running through the following pages is thus a belief in the vital necessity of a linkage between morphological and philosophic thought (1950: vii).

Arber talked about the study encompassed by the topic morphology, then traced the development of morphological thought through Aristotle, Theophrastus, Albertus Magnus,

Cesalpino, Joachim Jung, Malpighi, Nehemiah Grew, Goethe, and de Candolle. She discussed at length Goethe's concept of the *Urpflanze*, pointing out that it has mistakenly been considered to mean "primitive," an evolutionary concept, whereas Goethe meant a "conceptual" plant, an abstract idea.

Then came chapters titled "The Partial Shoot Theory of the Leaf," and "The Urge to Whole Shoot Hood in the Leaf." In subsequent chapters, Arber discussed other problems of plant morphology: floral parts, the root as a partial shoot, and an idea which was to be greatly expanded later, the relationship between the whole and its parts in the plant body.

The last chapter delved into the Aristotelian primary causes: *material*, *efficient*, *final*, and *formal*. For morphological purposes, she classified the first two as physico-chemical causes, and the latter two as teleological causes. Arber attempted to reconcile these apparently antithetic modes: "The division between mechanistic and teleological biology finds a parallel in the much emphasized contrasts between logical analysis and metaphysics; here, also, the antithesis is artificial. Seen justly, these two activities are not opposed to one another, but logical analysis occupies a special field of its own, within the wider domain of philosophy; this field is comparable with the limited province of physico-chemical interpretations within the larger realm of synthetic biology" (1950: 208). The mechanistic approach is analytical (reductionistic) but morphological thought must go beyond that to make clear the totality of the whole organism (synthetic).

The Natural Philosophy of Plant Form reflected Arber's concern with the history of biology, philosophy, and the study of and attempt to understand plant form. In her first book, *Herbals*, she had written: "He [Albertus Magnus] points out, for instance, that, in the vine, a tendril sometimes occurs in place of a bunch of grapes, and from this he concludes that the tendril is to be interpreted as a bunch of grapes incompletely developed" (1938: 5).

That idea resembles Arber's concept of the leaf as a partial shoot. In an article published in 1941, Agnes Arber first introduced the idea that "the leaf is a partial shoot, arising laterally from a parent whole shoot" and its corollary, "a partial-shoot which has an inherent urge towards the development of whole-shoot characters." She justified the use of such words as "urge," "endeavor," "effort," and "perseverance," as being "unavoidable because we have no other set of terms in which to express that compulsiveness by which the plant works towards a certain end, which, if we were concerned with a self-conscious organism knowingly pursuing a train of activity, would be recognized as a goal. For this reason, these ideas, and the words needed to express them, will not be avoided in the present essay; but it must be understood that they are not to be taken in the crudely anthropomorphic sense . . . [they are] embodying thought for which our stereotyped language no longer suffices."

Reviewers of *The Natural Philosophy of Plant Form* differed. A.G. Tansley (1951) opposed Arber's "anti-evolutionary bias." (In a letter to I.M.P. Browne (Arber Archives, AL85. 1 July 1937), Arber doubted whether there has been any large scale evolution at all.) Tansley

attacked her theory of the leaf's "urge" to shoot-hood: "We cannot help feeling that concepts which we are compelled to use in dealing with the human mind have been illegitimately transferred to plants," and ended his review with the question, "Have Plato's 'forms' or Aristotle's 'formal causes' any relevance at all to the objective study of nature?"

V. Puri (1952) disagreed: "Sir Arthur Tansley's comments betray lack of proper appreciation of Dr. Arber's point of view." He said, "The present reviewer sees little difference in the partial-shoot theory of Dr. Arber and the Telome theory of Professor Zimmermann. They are just two approaches to the same goal; one is ontogenetic, the other is phylogenetic." Puri called the book an "outstanding contribution from an eminent morphologist of long standing and vast experience."

In 1954 Arber published *The Mind and the Eye*. In the preface she wrote:

In the course of a period, extending over half a century, in which my concern has been with research in plant morphology, I have found my mind dwelling more and more upon the nature of scientific thought, and its relation to other intellectual activities. Such ponderings have led me gradually to realize how little I, as a biologist, could actually justify, or even, indeed, understand, the nature of the basic assumptions and modes of argument which, in accordance with scientific tradition, I was taking simply as 'given'. For the last twenty years I have been attempting to clarify my ideas on these subjects, with the aid of such reading in metaphysics as is within the compass of the amateur. In *The Natural Philosophy of Plant Form*, published by the Cambridge University Press in 1950, I have touched upon certain aspects of the botanist's attitude to his work. The present book offers a more generalized analysis of the biologist's approach to his own subject and to philosophy (1954: vii).

She subtitled her book *A Study of the Biologist's Standpoint*. Whereas *The Natural Philosophy of Plant Form* had been copiously illustrated, *The Mind and the Eye* had no illustrations, perhaps because Arber had moved away from dealing with plants to dealing with ways to understand plants. Arber introduced *The Mind and the Eye* by saying, "The biologist, asked to formulate the aim of his studies in the broadest and most general terms, might answer that he wanted to know, and above all, **to understand** [emphasis hers], the form, structure and behaviour, of living things" (1954: 3).

This encompassed five phases: stating the question, searching for data, interpreting the facts, testing validity of solutions, communicating the conclusions. Then she added a sixth:

In this the biologist stands back from the individual jobs to which he has set his hand, in order to see them in the context of thought in general; . . . and to discover how the intellectual and sensory elements, which they include, are interconnected. This urge is more likely to supervene late in life, since the contemplative spirit then gathers a force that it could not collect in earlier years, when the mind, in its fresh receptivity, concentrated its attention upon the delightful detail of the factual multiplicity of living things. . . . The worker may attempt to realize his own individual findings in relation to those far-reaching problems which are common to the various fields of thought; his activities at this level will then extend into the territory of philosophy (1954: 4-5).

This sounds autobiographical, a statement of the path which Arber herself has followed. The

first part of her book concerned the first five phases listed above; the second part was devoted to the sixth. Communication, she pointed out, was inherently difficult in that writing is linear, thought reticular. The biologist aims to arrive at the truth. "What is truth?" is a philosophical question which leads to "correspondence" (*Richtigkeit*, "correctness")--agreement with observed facts, and "coherence" (*Wahrheit*), which goes beyond the physico-chemical limits of empirical science to the essential nature of the whole organism. She gives an example: an artist can make a photographic representation of a landscape--*Richtigkeit*, or portray his own reaction to the visual aspect of the landscape--*Wahrheit*. In another example, the structure of an organ can be explained on purely mechanical grounds or it can be explained in teleological terms as formed for the express purpose of accomplishing some definite function. Each is true, but incompletely so. Together they approach more nearly to absolute truth than either alone.

In a chapter titled "Biological Antitheses," Arber discusses *form* and *function*, *subject* and *object*, *deduction* and *induction*, *mechanistic* and *teleological* views of the universe. "How?" questions can be answered on materialistic lines, but "Why?" questions require abstract thought. For example, a writer writes. We can say "How?" by describing the process of pen and ink leaving marks on paper (mechanism), but to say "Why?" we would have to leave the scientific realm and enter the world of thought, emotion, goal (teleology). The *mechanist* interprets the living thing by analogy with the machine. The *vitalist* supposes a guiding intelligence. The *organismal* approach suggests that "the vital co-ordination of structures and processes is not to an alien intelligence but is an integral part of the living system itself."

A plant has two antithetic stages in its development; vegetative growth leads to self-maintenance, whereas the reproductive phase often causes death and destruction of the vegetative phase, but leads to race-continuance. They appear antagonistic, but are reconciled when we remember that the organism, while unique, also represents the race. Reproduction is self-continuance in a broad sense.

Another antithesis presented here, the *one* and the *many*, the whole and the parts, became the subject of her last book, *The Manifold and the One*. The final chapter developed the antithesis of the *intellect* and the *senses* or the *mind* and the *eye*. Sense perceptions cannot be separated from mental activity. The brain and sense organs are a complex unity: "The close interlocking and interweaving of the data gained directly through the senses, with the concepts of pure thought, are peculiarly marked in the biologist's sphere of work" (1954: 124). "The goal of pure morphology [is] **the visual and the conceptual interpretation of the perceived**" [emphasis hers] (1954: 125).

Metaphysics studies "being," Natural Science treats of the corporeal world, and Natural Philosophy links the two. In his introduction to the paperback edition (Arber 1985), P. R. Bell wrote: "Many . . . would not follow Agnes Arber in seeing the biologist's task as set between the purely rational approach of the physical sciences and the more imaginative one of the humanities." And, "in this discussion, ["correspondence" (*Richtigkeit*) vs. "coherence" (*Wahrheit*)] despite Agnes Arber's persuasiveness, many will nevertheless feel distinctly

uneasy, and will not readily accept that biological science, as distinct from physics and chemistry, necessarily involves metaphysical concepts."

This book was not widely reviewed. Puri (1954) was favorably impressed. "By her mature thought and long contemplation, she has indeed illuminated, more than anybody else, the path of the biologist 'to reality'."

Agnes Arber's final book, *The Manifold and the One* (1957), carried her transition from morphology to metaphysics one step further, to mysticism. Published by John Murray, London, it is catalogued in the library under BD (metaphysics) whereas the others were QK (botany) or in the case of *The Mind and the Eye* QH (biology). It was not, as far as could be determined, reviewed in the scientific literature. It was reissued in 1967 by Quest Books, which "are published by the Theosophical Society in America, a branch of a world organization dedicated to the promotion of brotherhood and the encouragement of the study of religion, philosophy, and sciences, to the end that man may better understand himself and his place in the universe. . . . Quest Books are offered as a contribution to man's search for truth" (Arber 1967: back cover).

In the introduction Arber relates how, as a child, she came to the idea that such qualities as justice, love, and truth are in reality one, and:

Year after year the mystery of Unity and the Manifold has held its place in the background of my mind, gradually becoming so insistent that I was impelled irresistibly to try to approach it on various lines. I soon found that in trying to think about the nature and the relations of the One and the Many the simple linear type of thought and argument, which is used in dealing with scientific problems, does not suffice. . . . [We must] feel our way towards a maturer kind of thought by first carrying the discursive process to its utmost limit, and then outdistancing it and entering a region which lies beyond logic (1957:xi).

Reticulate, rather than linear, thinking is necessary. The chapter headings and page headings such as "Unity and the Contemplative Experience," "Transcendence and Immanence," "Return to Earth From Mystic Union," and "Mystic Beatitude" indicate that *The Manifold and the One* is a difficult book for a scientist to read and understand because of a paradox. The very nature of mysticism is contemplative and intuitive. The mystic enters a world of pure thought that cannot be reduced to the symbols which words are. Therefore, mystics cannot communicate adequately what they are contemplating.

Arber cites writings from philosophers and mystics from various cultures who were concerned with this relation of the one and the many, the whole and its parts, unity in the manifold. A Persian mystic, Jili, uses a metaphor of a wall "seen at close range" which "is observed to consist of a multiplicity of various components (bricks, mortar, etc.) but when viewed from a distance it reveals only its essential 'wallness,' so that its multiplicity is fused into unity" (1957: 2).

Arber finds that "mental effort of the rational discursive order cannot, unaided, account for the

passage from the Many to the One, so we must make some attempt to understand that other mode of thinking, which eventuates in the contemplative or mystical attitude" (1957: 13 14).

This relation of one and many is seen in the life of an organism which starts as a single cell, matures by the development of many cells and parts, until it reproduces by returning to the singleness and oneness of an egg. "It would be unnecessary to catalogue all the philosophers of East and West who have found that the most strenuous attempts to carry logical thought to its utmost limit eventuate inevitably in mysticism" (1957: 57). Arber relates the human mind and body as the type example of the One and the Many and brings in eternal and temporal, reason and emotion. She concludes:

Yet even we, despite the limitations of our insight, may find that long and intensive pondering will have so far fostered our fitful inward spark that we return to the starting point with at least a glimmering torch, able to irradiate, though dimly, the fringes of the mystery. If the light is sufficient to disclose to us the way of contemplation that lies within ourselves, we may by pursuing it to the end come to know not as a mere static dictum but as a winged intuition, carrying an infinitude of significance both for mind and heart that the One is the Manifold, and the Manifold is the One (1957: 118).

The paradox Arber explores in this book, the relationship of parts to a whole, is pervasive throughout all levels of the biological world: electrons and atoms, atoms and molecules, molecules and compounds, compounds and cell organelles, organelles and cells, cells and tissues, tissues and organs, organs and organisms, organisms and populations, populations and communities, communities and biomes, biomes and the biosphere.

Arber, in her life, has traced the life of many mystics. When young, one acquires experience, seeks to know how things work. As one grows older, she or he seeks to understand why they do what they do, the purpose of life. With age, action decreases, contemplation increases. Less time is spent doing and more time is spent *thinking about* what one is doing. One cannot pursue the second stage without going through the first. Unfortunately, the *how* is subject to careful description because it deals with physical reality such as length, mass, temperature, and form; but the *why* is more difficult to put into words, because it deals with abstract reality of emotions and thoughts. The farther one progresses from mechanism through metaphysics to mysticism the more ineffable it becomes.

Morphology, as the study of form, must move past mechanism to metaphysics because form can only be understood in relation to *function*. Mechanism is the physico-chemical nature of an organism. Metaphysics is more difficult to define. The word means "beyond physics." The *American Heritage Dictionary, Second College Edition* defines it as "the branch of philosophy that systematically investigates the nature of first principles and problems of ultimate reality, including the study of being (ontology) and, often, the study of the structure of the universe (cosmology)." *Webster's New International Dictionary, Second Edition* states that at one time "metaphysics was understood as the science of the super sensible." Mysticism, in the *American Heritage Dictionary*, is defined as: "1. a spiritual discipline aiming at direct union or communion with ultimate reality, or God, through deep meditation or trancelike

contemplation; 2. a belief in the existence of realities beyond perceptual or intellectual apprehension that are central to being and directly accessible by subjective experience, such as by intuition."Mysticism is usually intertwined with religion because it seeks ultimate reality, which is often considered synonymous with God.

Although brought up in the Church of England, Agnes Arber was not a believer in Christianity according to her daughter, Muriel. Her transition to mysticism was not an attempt to reconcile previously held religious convictions with her scientific work, but rather her life long "passionate search for--truth, not exactly--search through botany, metaphysical things, to find the truth about things" (Muriel Arber, interview).

As Arber discovered how a leaf grows, she was working in the world of mechanism or natural science. When she sought to understand why it developed that way, she moved into metaphysics. As a morphologist she realized that a true understanding of the leaf required her to go beyond the simple world of physical science into the metaphysical. When she tried to contemplate the relation of the leaf to the whole organism and the organism to the whole universe, then she became a mystic.

Agnes Arber's startling statement, "The leaf is a partial shoot . . . which has an inherent urge towards the development of whole shoot characters" resulted from her seeking to understand the true nature of the leaf as a part of the plant and the difficulty of expressing this understanding in scientific terms.

[1] At Cambridge University, the examination for honors. The name originally applied to a three-legged stool on which a Bachelor of Arts sat, appointed to dispute humorously with candidates for degrees, according to Webster's New International Dictionary, Second Edition.

[2] The other was Girton.

[3] Virginia Woolf published an essay titled "A room of one's own" in 1929, based on papers read at Newnham and Girton in October, 1928, to put forth her opinion that "a woman must have money and a room of her own if she is to write fiction." Perhaps we should paraphrase Ethel Sargant, "Independence is the essence of **creativity**."

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