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Live Matter: Towards a theory of plant life

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Abstract

Planting endures unquestioned in landscape architecture through a reliance on the authority of scientific botany and design expertise. While plants represent the intersection of life and matter, the discipline of landscape architecture only recognizes plants for supreme utility or divine beauty: our collective desire to domesticate. The ensuing planting procedures rely on a lineage of practices that pacify the aliveness of plants, as choice parts and reductive binomials render plant form. By using the term 'live matter', I suggest that plants can be reoriented and recognized for their aliveness. This reorientation is substantiated by an alternative botanical framework, which lies outside the burden of economically driven botany or reductive typologies of formal composition. In the following article, the botanic contributions of three scientists—J. W. Goethe, C. Darwin, and A. Arber—are described in order to expand the practice of planting in landscape architecture, so that identification of parts can be replaced with the potential of formation. This decentering introduces a provocative new perspective on the living, breathing organisms that are all around us yet seldom fully appreciated. Can plants ever be reclaimed as a series of transformations, a creative collaboration, or a philosophical subject, despite centuries of fixed practices and parts procedures?

Planting / plant morphology / ecology / botany / representation

Figure 1 The *Live Matter* Archive summarizes botanical history and highlights particular treatises that explore the plant as a living subject.

Planting—*to plant* or to fix in place—is at the core of landscape architecture. Yet nothing in landscape architecture has become more fixed in place than perceived notions of plant life. As one of the most rehearsed procedures, planting endures unquestioned through a reliance on the presumed authority of scientific botany and the aesthetic intuition of design professions. Plants represent the intersection of life and matter, yet the discipline of landscape architecture only recognizes plants for supreme utility or divine beauty; our collective desire to domesticate. The ensuing planting procedures rely on a lineage of practices that pacify plants, and benefit from their most predictable behaviours. Such procedures render the plant a static object through catalogues, silhouettes, and guidebooks that serve as vocational tools, encouraging the spread of more figures, indexes, and static procedures. Fixity is established by dismembering the plant into assessable parts that can be verified through measure. Because of the inheritance of these fixed and fragmented practices, the field of landscape architecture rarely questions how it recognizes plant life, much less why planting has become procedural.

This paper emerges from a research initiative entitled *Live Matter*, a framework that aims to expand inherited procedures by considering plants as a critical design medium (Fig. 1). The primary objective of the research is to achieve an appreciation of plant life by including observation, collaboration, and philosophy as important methodological and epistemological agendas for landscape architects. This is explicated using examples from a lineage of studies in historical botany (Fig. 2). The ambition of the research is furthermore to identify the gap between methodology and practice in planting design in order to offer a structure with which to advance the human relationship to plant life. Therefore, it specifically addresses the loss of plant knowledge in the field of landscape architecture.[1] It builds upon the precept that landscape architecture distinguishes itself within the design fields through the creative application of plant knowledge and planting procedures.

Live Matter offers an alternative botanical history that can help broaden the description of plant life. The research suggests that plant life has agency outside of the burden of economically driven botany or reductive typologies of formal, fixed composition. These practices reflect a longstanding perspective that assumes that non-human material is passive, and devoid of life.[2] This is especially relevant in order to augment the expanded role of landscape practice that has advanced the complexities of urbanism, infrastructure, and broadly defined ecology.[3] While practices such as landscape and ecological urbanism have an impact on the operations and scales of the profession, they have yet to reorient fundamental procedures, having neglected to advance a theory or a practice that challenges our ability to scope, specify, and describe planting.[4] Horticultural techniques continue to underscore ecological scales, as cover is specified in static units that are procured and installed in a manner that denies movement and transformation, associating plant life with all other non-living material.

Yet, within the pressing realities of climate-based risk, land degradation, and severe urbanization, the role of plant life has shifted considerably. Plants no longer necessitate authoritative practices substantiated by the sterility of credentials of listing, identifying and naming.[5] Today, the behaviour of plants as an active series of temporal and developmental processes has become more crucial than ever.[6] How can an expanded theory of plants permeate and inspire the frameworks of practices that adhere to the same procedures of planting?

Rather than unpack anecdotal accounts of economic gain and exploitative trade that have reduced plants to binomial categories, desiccated samples, and the promotion of convenient attributes, *Live Matter* invokes an agenda for plant life within the history of theoretical and philosophical botany. The research contends that the loss of plant knowledge is due to the presumption that plants are immobile, static, and devoid of agency and suggests a revisionist history of individuals that specifically include and speculate on plant life *for its own sake*.[7] Furthermore, *Live Matter* aims to engage the profession of landscape architecture precisely because the field rehearses the procedures of planting that operate between nature and culture or human and non-human agency. As a form of design research, the project argues that histories and references be reimagined in order to create a more significant role for planting in practice (Fig. 3). A theory of plant life can restore our procedures by considering plants as (1) live matter, (2) subjects of philosophical inquiry, and (3) agents between the human and non-human.

Applied plant morphology

The procedures of planting are dictated by a scientistic history of classification and taxonomy driven by economic botany. The given narrative perpetuates an industrialized perspective on plants that emerged through the volumes of medieval herbals, into the drawers of Linnaean classification, and across the territory via colonial trade routes.[8] Specialization in the botanical sciences developed in order to reinforce the economy, reducing the plant to a metric of human progress. Each stage increased the specialization of particular parts, dismembering the plant in order to increase the legibility of the discipline. Classifying life in this way yielded a particular treatment of living matter in subsequent global expansions and narratives, including early environmentalism.[9] Within this tradition, plants are generally studied according to their kind, their structure, or their value. Each procedure helps articulate the plant as a technical artefact reduced to recognizable parts: wood, seed, resin, bud, flower, fruit, and nut. As plants amalgamate in space, they serve to demarcate territory and amass relationships according to uniform spatial agendas: shade, climate, ownership, cultivation, and timber.[10] The most current episode in this botanical narrative is characterized by the spread of fear, including the threat of mass extinctions and the biased alarm against non-native species. Even the most recent botanical speculation reflects a longstanding desire to organize and control the processes of plant life.

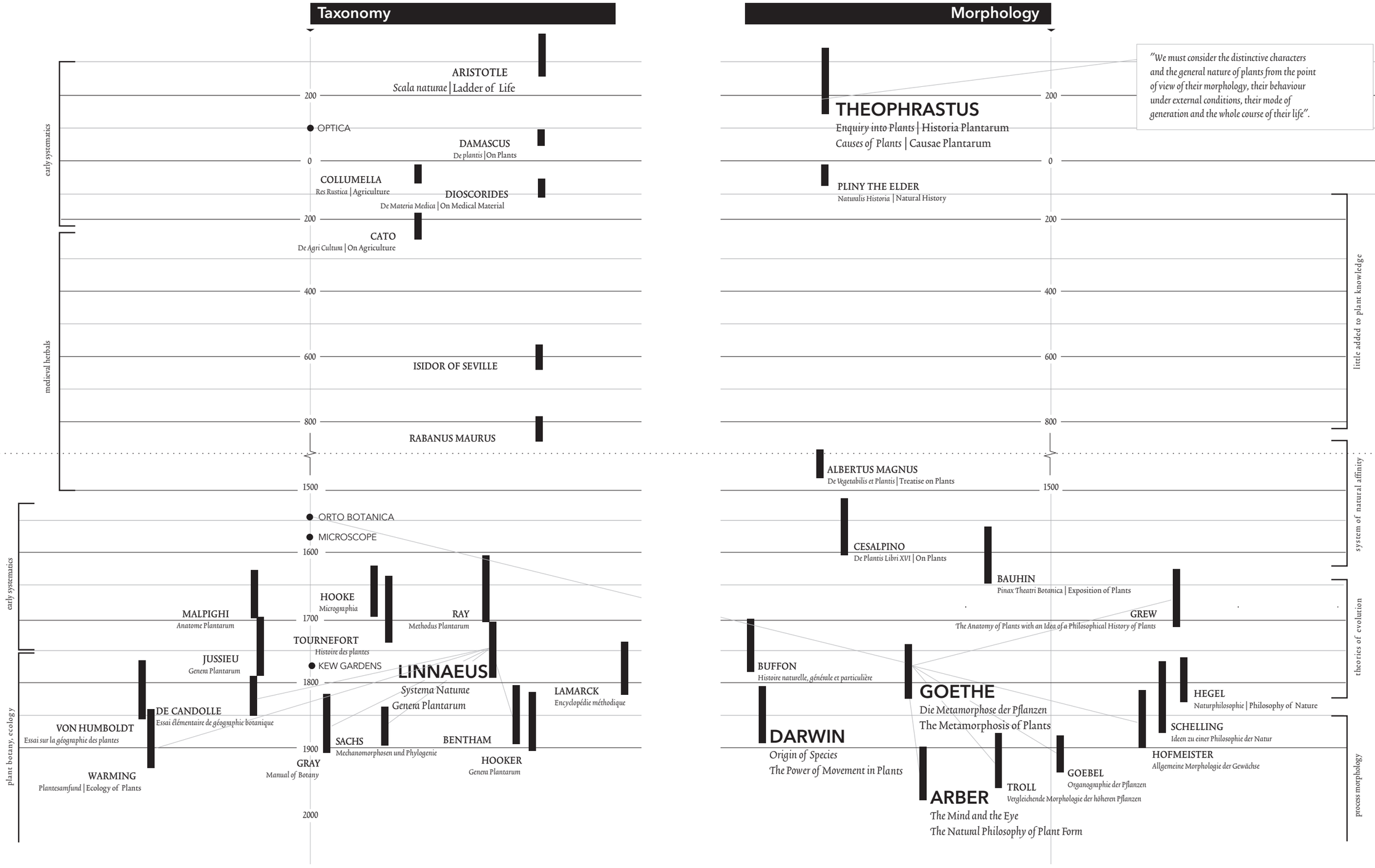


Figure 2 The *Live Matter* timeline explores the divergent lineage between taxonomy on the one hand and morphology on the other.

Figure 3 Installation views. Visitors engage with a freely available copy of the *Live Matter* archive in the gallery space at Harvard Radcliffe Institute, 2015.

In order to appreciate the fuller origins of botanical thought in this context, it is necessary to include the creative endeavours of plant morphologists, a science that acknowledges plant life outside of pure utility or aesthetic beauty by defining the study of change in form over time.[11] The inclusion of time can be defined as formation, an important insight into how the scale of biological development generates powerful environmental adaptations. In this research, the study of plant formation is advanced using the practices of select individuals in scientific history, with the aim of advancing a more nuanced approach to planting in landscape architecture. The lineage of morphology, a largely German science, runs counter to the reductive dissections of domestication common to identification and taxonomy, which necessarily conceive of the plant in parts.[12] Applying morphological scholarship advances an awareness of the entire plant organism over time, acknowledging that the development of a plant is as important as its final shape.[13] When structures in different species are believed to exist and develop as a result of common, inherited genetic pathways, their material becomes fluid, roots grow into stems, from stems emerge branches, from which leaves develop. Morphology breaks the tendency to isolate and dislocate the plant and offers a uniform structure that unifies the material composition of the plant world.[14] Familiarity with the plant as a growing dynamic disables the fixity of form. Plants grow, adapt, and change, are aggressive and display irritability outside of our ability to predict and tame them. Therefore, the research challenges fixity and prompts landscape architects to work with the aliveness of plants.

It is not a simple task to account for the absence of morphological thought in landscape architecture, despite its impact on botanical scholarship. This research contends that this detachment is—at least in part—the result of unquestioned and inherited histories that advance a technical and colonial attitude towards plant life. Mainstream botany has been so effectively impressed on the profession that we inherit the perception that every plant was put on earth to be of service to humans. Despite numerous brilliant texts that elucidate plant morphology, even the botanic sciences have largely forgotten the ground rules of plant development.[15] Even as this assertion seems preposterous in relation to current conceptions of ecology and the environment, by assuming dominance over plants, scientists could establish authority whereby plants could be explained and horticultural exploits could be justified. Specifying plants at the scale of ecological systems is nearly non-existent now, as the practice of horticulture contradicts the formation, spontaneity, and mobility of plants.[16] Why has the profession of landscape architecture inherited knowledge in fragments whereby plants are only considered a formal feature, a tool, or a statistic in greening initiatives? We have yet to reassess our prescribed botanic inheritance, despite an array of new challenges being absorbed by the profession. Perhaps, as a field, we can acknowledge that our procedures are more dependent on reiterating known methods than on advancing a critical theory.

Excavating an archive

The research framework proposed by *Live Matter* emphasizes the contribution of botanical scholars who preserved the plant in its entirety and elevated study by expressing concealed plant formation. Accordingly, the project is both archival and historical, offers a parallel description of plants that explicates the role of morphology, rather than taxonomy. Reflecting upon plants as *Live Matter* necessitates unique references, experiences, and descriptions. Common to each protagonist in this account is an unambiguous assertion that plant life is something other than human or animal life, sharing a temperament for uncertainty, mystery, and doubt, engaging with both verifiable detail and speculative theory.[17] Plants are described as a novel subject without human sentimentality or ecological remorse, diverging from mechanistic sciences through vivid descriptions, novel experiments, poetry, and illustration. The subsequent archive of treatises and texts expose the appeal and scalar potential of plant formation, as opposed to the static order of form.

In particular, the botanical contributions of three scientists are extracted from the *Live Matter* research: J. W. Goethe (1749–1832), Charles Darwin (1809–1882), and Agnes Arber (1879–1960). Taken together, their work explicates morphology though methods that relied on careful observation, establishing a relationship between human and plant scales. Their combined efforts offer an alternative to the dualistic readings that counter-pose qualitative and quantitative information, art and science, scientific proof and verifiable observation—ultimately humans and plants. Rather than merely highlighting the views that have created the dissociation between scientific and philosophical botany, a natural history of *live matter* is proffered here to reinforce the creative study of plants. A re-examination of the brilliant achievements of these scientific pioneers generates a variant discourse on plant life that is particularly relevant to contemporary landscape architecture as a discipline.

Goethe: Beyond classification

In trying to understand the origin of form, German philosopher-poet Johann Wolfgang von Goethe (1749–1832) proposed the study of morphology for the first time in 1790. Morphology, as he described it, privileged the representational similarities between internal plant development rather than seeking evidence to describe outward appearance. As he memorably stated, morphology's intention is *to portray rather than explain*.[18] While his initial speculations relied on the Linnaean plan to describe plants, he diverged quickly from systematic botany, writing that he was disinclined to reduce his botanic studies to diminutive language or the counting of floral parts.[19] Accordingly, Goethe maintained that he had learned a great deal from Linnaeus, but that what he had learned was *not* botany.[20] His scepticism towards classification ultimately led him to determine that the binomial system of classification imposed limitations on the plant world, and decided that it could not lead to a closer understanding of genera and species.[21] He feared that botanical science would be reduced to memorization of principles, as it has tended to do in landscape architecture curricula. Instead, Goethe reoriented his interest on plant science, by conceiving of plant life as a fluid series of transitions. At the time, the term 'metamorphosis' was used to describe discernible life stages according to an identified plan, illustrated for instance in the lifecycle of an insect.[22] Goethe resisted the prevalence of fragmentation embedded in the identification of numbered stages. Recognizing that plants could not be forced into categories of development, he advanced a theory of the plant as a collection of slowly dividing cells, establishing the foundations of plant morphology:

> I had not ceased to go forward along the path marked out by Linné upon which, however, I found a good many things holding me back if not actually leading me astray. I conscientiously attempted to apply botanical terminology to plant parts, but unfortunately was very greatly impeded in the process. For instance, when on the self-same stem I saw what was indubitably a leaf gradually turning into a stipule, when on the self-same plant I discovered first rounded and then notched, and finally almost pinnate leaves, I lost the courage to drive a stake or even draw a mere line of demarcation.[23]

Goethe's reference to *driving a stake* or drawing a *mere line* clearly aligns with his passion for the fluidity of plant life. From Goethe's perspective, his era of scientific research yielded a limiting dependence on measure-

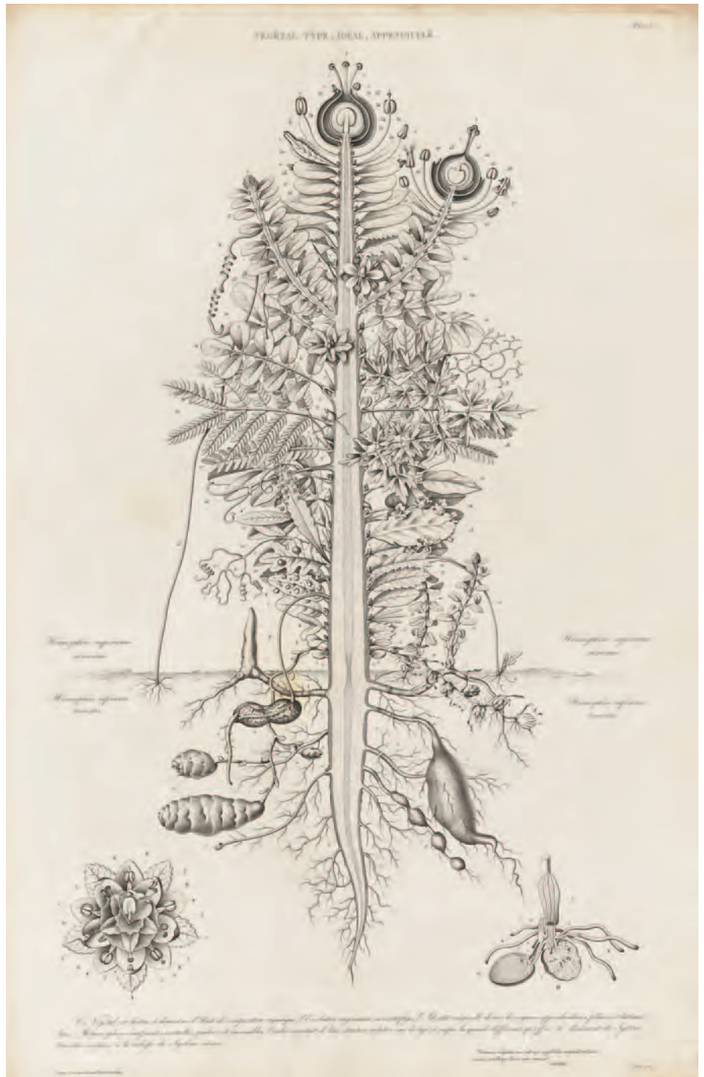


Figure 4 *The Plant Archetype* appeared in Goethe's 1837 edition of his works on natural history and was illustrated by P. J. F. Turpin, who memorably stated that seeing ideas is the best way to explain them.

Figure 5 Rootlet, *Populus alba*. Detail of the similarity between root and shoot. *Live Matter*, at Harvard Radcliffe Institute, 2015

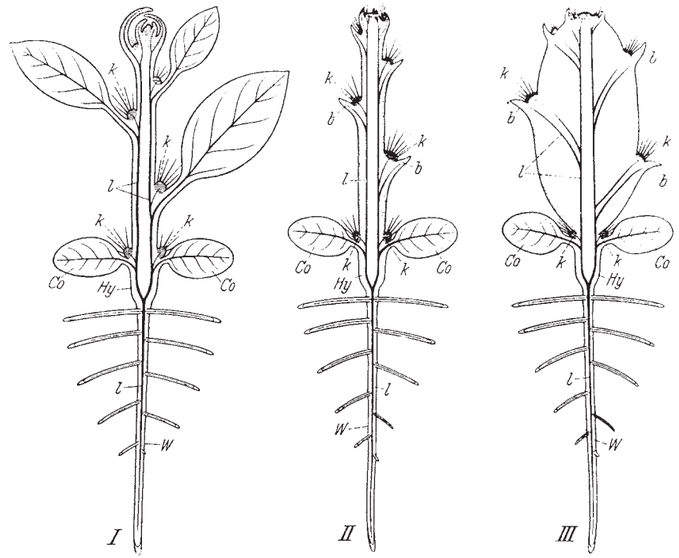


Figure 6 Dissipation of the cacti form, *Urpflanze* schema. Illustration by Wilhelm Troll (1897–1978) in: K. L. Wolf and W. Troll, *Goethe's Morphologischer Auftrag: Versuch einer naturwissenschaftlichen Morphologie* (Tübingen: Neomarius, 1950). Troll continued the morphological traditions established by Goethe, by exploring the archetypal plant and advocating for a science that unified plant life.

ment through instruments and on order through taxonomy. These two approaches, he believed, were quick to confirm 'truth' rather than articulate and convey knowledge.[24] For Goethe, organic entities only ever achieved temporary form, continually forming and transforming, and as a result could never be understood as being *formed*. In Goethean terms, the study of plant life was based on first-hand experience and observation, so that even when using instruments, plants could only be understood by paying close attention to what he describes as *constant activity*.[25] Goethe was well aware of the captivating descriptions that had emerged from early microscopic science, in particular Robert Hooke's *Micrographia* (1665), but declared that it had no relation to thought since Hooke had only reduced the living world to a series of static objects, in finished states. The act of enlarging—of increasing knowledge through magnification—implies that bigger is better, that knowledge is enhanced with amplification. Increasing measure through scale became an explicitly modernizing technique that sanctioned strict delineations between organs.[26] Magnification considered in this way thus poses major aesthetic and experiential questions.

As Goethe repudiated generic form and the use of tools, he applied his botanical skills and observational sensitivity to reveal a primal plant, or what he termed the *Urpflanze*. In *Die Metamorphose der Pflanzen* (1789), he proposed this plant or *ur-form*, as a primal plant structure or model from which an indefinite number of forms could be derived (Fig. 4). Individual metamorphoses were achieved through the basic principles of growth and convergence, which persist through a continuous process of differentiation—or cell elongation. Thus, Goethe anticipated the concept of indeterminate growth, a crucial difference between animal and plant life.[27] Indeterminate growth is development that continues indefinitely, revealing plants as a process, with no predetermined body form that matures in size. Rather, Goethe's model plant proposes that development unfolds in repeatable modules, enabling the plant to shed and generate new organs, changing exterior form in close association with internal structure and environmental influence.[28] The plant is not an object, it is a morphological swarm.

Botanical science was a precious adventure and a mystery to Goethe. Its features resided not in the distinctions between types or in *mere lines*, but in the core tenets concealed in plant formation (Fig. 5). This logic was what brought Goethe to propose the philosophy of metamorphosis (the origin of plant morphology) and to posit the concept of a model organism:

> The primal plant will be the strangest creature in the world, which Nature herself will envy me. With this pattern (model) and the (key) code to it, one could go on endlessly inventing plants which would be logically possible even if they do not actually exist; they would not be merely artistic or poetic illusions, but would have an inner truth and obligation.[29]

Goethe anticipated that plant life was structured on a similar internal logic that simply manifested differently on the outside. Rather than rely on the limiting terminology of stages, Goethe adjudicated the term morphology to define a plant's ability to generate novel arrangements. As individual metamorphoses are achieved internally, they endure through a process of differentiation that manifests differently on the outside—or as cellular development encounters the environment.[30] This means that plants do not advance in discernible stages that amalgamate towards an end state, but are in an *endless* state of formation. Goethe's morphology did not expand or refine existing classifications; it presented a method for dealing with environmental dynamics and change over time.[31] Thus conceived, morphology is an open-ended process of encounters that tests the limits of parts procedures and fixed, commodified form.

In articulating a method to describe change over time, Goethe examined the mutable character of development, reasoning: '*Alles ist Blatt.*' From this perspective, the dynamic of transformation becomes archetypal; a discernible internal logic common to all leaves, stamens, stipules, etc. (Fig. 6). The root tip and the shoot tip may appear different, but behave and advance in the same manner, using the same model. Goethe was envisaging what is now known as the process of cell division, which is entirely responsible for growth in plant life.[32] The multiplication of cells is influenced by both biological and environmental contexts, as each species manifests itself as distinct and individual. Every plant organ attains its size and density through the continuous division of cells, uniting seemingly dissimilar parts of the plant through perpetual transformation, known today as homology.[33] Through the lens of morphology, plants are assemblages of developmental growth and form, structured internally through time and externally through space. This is what Goethe reveals in one simple quote, one magnificent moment reflected through careful observation: 'Everything is leaf.'

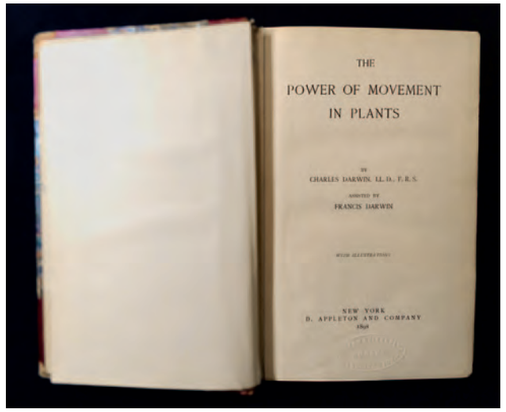

THE
POWER OF MOVEMENT
IN PLANTS
BY
CHARLES DARWIN, LL.D., F.R.S.
ASSISTED BY
FRANCIS DARWIN
NEW YORK
D. APPLETON AND COMPANY
1900

Figure 7 Charles Darwin (assisted by F. Darwin), *The Power of Movement in Plants* (London: John Murray, 1880)

This Goethean model also reveals the fine coordination between underground and aboveground plant parts, since roots are simply horizontal shoots running across or below the soil surface. Root and shoot are the same at a cellular level, activated by constant chemical signalling back and forth to sense and respond.[34] The root system is a geography of meristematic activity that helps a mesh of rootlet tips participate in the formation of landscape types, from forests to deserts.[35] However, the study of roots and rhizomes is complicated by their position underground, just as any analysis of the system sparks a process of decline in the aboveground plant. As a result, the entire plant is rarely considered, contrary to the attention paid to its most visible features.[36] This is especially noticeable when dynamic transformations are construed as fragments. Extracting parts, labelling stages, and overlooking concealed transformation reduces planting to a procedure. Plants become tools. For instance, in the design and management of living environments, landscape architects have been trained to believe that roots only help to keep plants fixed, when in effect the root system is actually what enables the plant to move.

Darwin: The power of an experiment

In 1880, Charles and Francis Darwin suggestively titled their study of tropisms *The Power of Movement in Plants*. The publication was an exhaustive study that charted the contact points, angles, and momentum accumulated through plant development (Fig. 7).[37] Plants did not just grow, or mature; they could move powerfully through the environment. The consequences presented an understanding of plant life that builds on Goethe's assertion that plants are made up of a succession of developments, by proving that the entire plant cooperates—from root to shoot—in an effort to survive. Each meticulous experiment embedded in the study of movement projected the rise of plant physiology and biomechanics, demonstrating that evolution could account for behavioural response.[38] Darwin's long-term interest in the adaptive qualities of plants is substantiated by these studies, yet plant movement remains one of his most unfamiliar achievements since it was not universally accepted upon publication. It was only a century after publication that the power of Darwin's botanical investigations would be confirmed as an important aspect of evolutionary theory.[39] Darwin anticipated that plants routinely exploit their environment, in much the same way that animals do.[40] Through the lens of Darwinian experiments, the economy of plant movement was construed as the very essence of a more useful description of plant life.

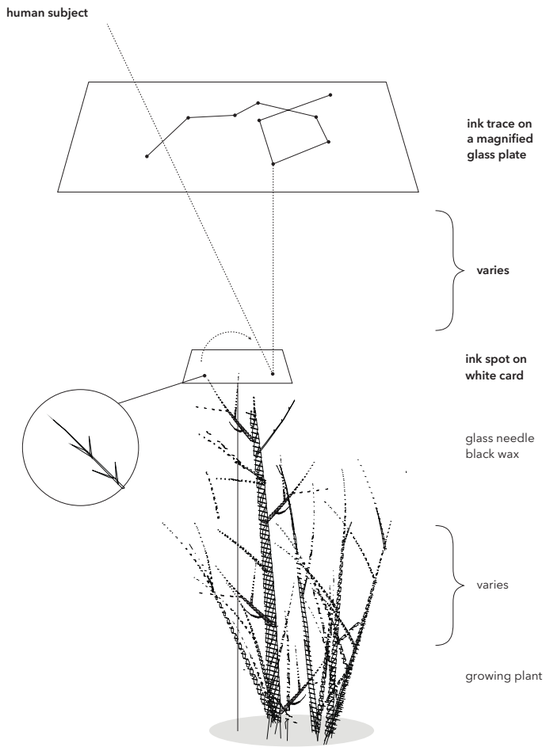
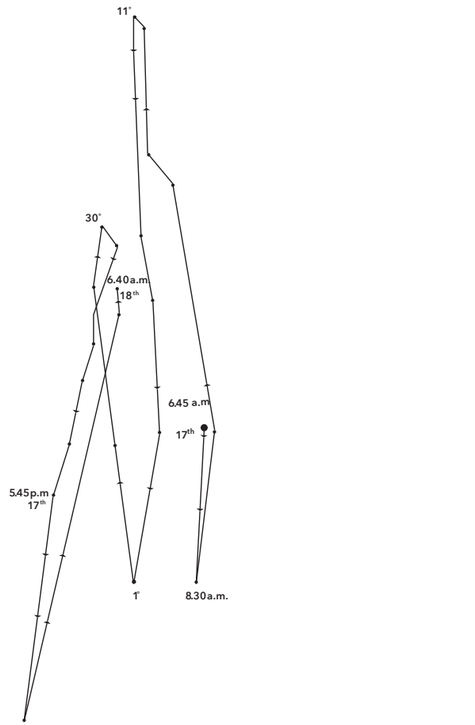
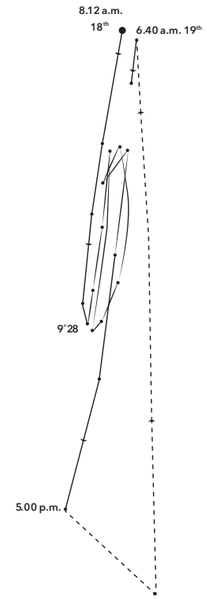


Figure 8 Darwin's discovery of the circumnutation of roots, shoots, and leaves in their search for soil, light, or shade. His experiment, using the tracings from a glass needle attached to the tip of a plant with some sealing wax, marks the progress along a white card in a fixed position. A glass plate in a variable position was placed above this, producing a magnified record of movement (After: M. Allan, *Darwin and His Flowers: The Key to Natural Selection* (London: Faber and Faber, 1977), 279).

Darwin preferred to call on 'the aliveness of plants' rather than the more common 'life of a plant', a minor but distinct nuance that finds resonance in his methods.[41] His work with plants is characterized in the experiments he conducted with his son, in order to publish *The Power of Movement in Plants*. The analysis did not interpret movement from a distance, through aerial views of vegetation patterns at ecological scales, but through direct engagements with plant life at the scale of the organism. By suspending a glass plate above the growing tips of each seedling, and gluing glass needles to their shoots, the plants traced their own





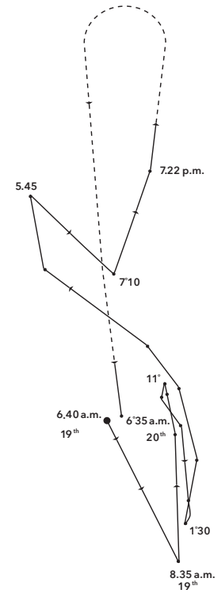


Figure 9 Circumnutation of *Oxalis rosea*, *Oxalis vuldiviana*, and *Oxalis rosea*. Redrawn after illustrations in: C. Darwin, *The Power of Movement in Plants* (New York: D. Appleton and Company, 1900 [1880]). Darwin's tracings demarcate temporal development along a glass plate, carefully recording the movement of plants in time and space.

progress across the plate with a sticky wax that allowed Darwin and his son to record movements using key points on the other side of the plate (Fig. 8).[42] Through iterative experimentation, Darwin concluded that all organs of all plant species rotated, or circumnutated, continuously.[43] The method preserved the living plant—or its aliveness—suggesting a novel collaboration between the human scientist and non-human plant organism. The resulting diagrams present an indexical model of plant formation, registered as a sequence of traceable, isolated activities that when taken together express universal movement (Fig. 9). Plants are proven to be independent organisms, propelled not only by external stimuli, such as the influence of light, gravity, and water, but *because they choose to*. Thus, plants are not dependent on their environment; they exploit it just as humans and animals might, in order to advance their own species.[44] Repeating the experiments through the micro-movements from root to shoot tip, Darwin eventually influenced a macro-reading of the subject as a whole: the powerful progress of all terrestrial plant movement.

The choice of the experimental method usually depends on the research aim of the investigator. Thus, an essential part of scientific study positions the human outside the subject of the experiment and abstracts the results in order to produce information.[45] A reliance on tools and techniques supports this indispensable authority, in order to mobilize science as a field. But movement is not a subject without an entirely novel form of experiment, nor can it be a procedure without a complete redefinition of the subject. For Darwin, research was a *collective experiment* with which to discover what humans and non-humans are able to produce or withstand.[46] Darwinian science was accompanied by tedious and time-consuming experimentation, notable for its ability to regulate the experiment but not the subject. Darwin collaborated with the plant, altering the experiment to the demands of the plant. He conceived of a human experimental process calibrated to the advanced slowness of plant development. In tracing plant movement, Darwin explicated that small movements accumulate in concert with stimuli to describe the growth of new parts. For the purposes of building a *Live Matter* archive, Darwin's experiments are significant for his equal consideration of the root and shoot, recognizing the entire living plant as his collaborator.

Darwin exposes the similarity in tropisms between root (gravity) and shoot (light), an intriguing approach to plant life that activates its entirety (Fig. 6). In particular, his experiments studied and recorded the movement of the radicle, which is the primary structure that emerges as the root develops.[47] He describes its bends, sensitivities, and actions, at the scale of germination—the first instance of sprouting. Thus, the power of movement is attributed to the ability of a seed to reposition itself in relation to the forces of gravity, since the radicle emerges first. Darwin compares this series of readjustments to a man thrown down on his hands

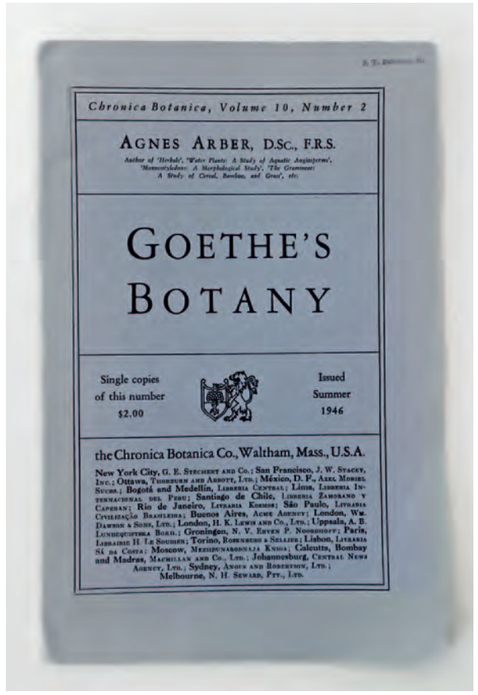


Figure 10 A. Arber, 'Goethe's Botany', *Chronica Botanica* 10/2 (1946). It is noteworthy that Arber translated 'Goethe's Botany', bringing morphological considerations to the English-speaking world.

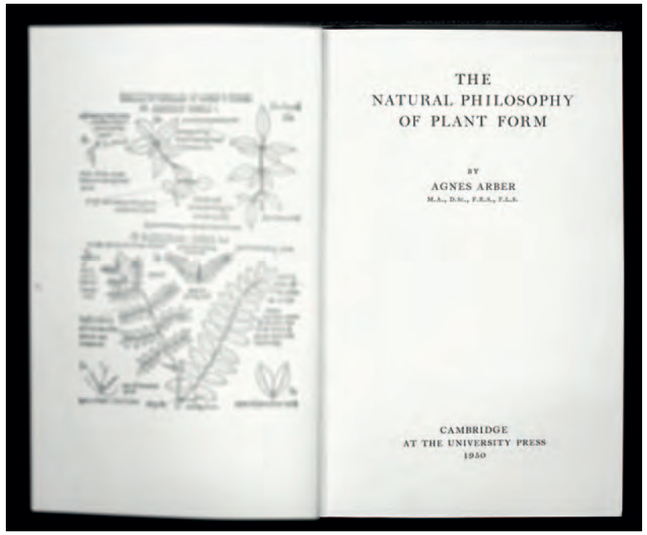


Figure 11 *The Natural Philosophy of Plant Form* was released in 1950, and was criticized severely by the scientific community for having disregarded the influence of phylogeny on plant morphology. However, the book is exceptional for providing a history of creative botanical thought, and offers a complete chapter of the definition of morphology as a field.

Figure 12 *Live Matter* Installation. The root system is elevated in a gallery setting, in order to contemplate the intact root system. The result questions fragmented practices and a lineage whereby plants are only considered a formal feature, a tool, or a statistic in greening initiatives.

and knees, while bearing the weight of a load of hay landing on him. He describes the immediate wriggling required to right oneself, freeing pressure from the mass of the burden. The bale would be loosened, as space is released for movement. Once achieved, he describes the analogy candidly: 'The man, still wriggling, would then raise his arched back as high as he could; and this may represent the growth and continued circumnutation of an arched hypocotyl or epicotyl, before it has reached the surface of the ground.'[48] Darwin proves that the radicle controls most micro-movements, including the subsequent shoot activity. *The Power of Movement in Plants* advanced a controversial view of plants by comparing the root apex with the intelligence of an 'animal brain'.[49] Here, seemingly minute behaviours accumulate across the surface of the earth, as plants disperse seeds across vast landscapes in their race for survival.

In each experiment, the root becomes a predictive structure, which unites with photosynthetic intake in order to control how the plant advances through the soil. In this publication, Darwin proposes that plant movement is structured by external physical laws but regulated and controlled internally, by the living organism. For instance, he explains the absorption of water by the rootlets and the exhalation of it by the foliage, recounting the upward and outward spread of plants. Thus, the influence of Darwin's movement is physically manifest in how a plant colonizes the ground. The resulting textures of suffocating and trailing behaviours that rework landscapes are the formal result of the micro-movements he identified. Plants displace, conjoin, sequence; they are irritable, sensitive, or combative and display a range of postures including anticipation and mobility. In this way, biological accumulation creates spatial impact and transformation. Over a century ago—prior to ecology as a discipline—Darwin confirmed that it is not the environment that shapes plants, but plants that shape the environment.

Arber: Plant philosophy

In 1946, Agnes Arber translated Goethe's *Die Metamorphose der Pflanzen*, introducing morphological theory to the English-speaking world and offering a glimpse of German naturalism (Fig. 10). Arber was a significant contributor to the elaboration of plant morphology as a discipline, offering not only English translations of various German texts, but also advancing an appreciation for science as a theoretical endeavour.[50] Arber exemplified 'plant thinking' as she insisted that science was meaningless without contemplation and reflection.[51] While her work relied on elaborating Goethean botany, it is on the basis of her creative and confident assertions that plant morphology can be considered both a philosophy and a discipline.[52] The sheer quantity of Arber's publications demonstrates a remarkable mind, even before taking into account the quality of her research, the clarity of her language, and the meticulous observations that she brought to her work. Interest in Arber's scholarship has increased over time, though it has yet to approach the level of her personal dedication: in sixty-eight years of research and writing, she produced eight books and 218 other publications, including thirteen poems.[53] Not unlike other scientists in the *Live Matter* archive, the reception to her publications varied, as the scientific community and their normative botanical societies rejected her work as overly theoretical and speculative for any serious inclusion in the sciences. The questions she raised put science to the task. Arber was as interested in thinking about *how* botany was done as in what it was achieving.

In order to establish a basis for her own creative scholarship, many of Arber's publications began with a consideration of botanical thought in the history of science. Her craft of assembling and elevating a scientific setting for plant morphology continues to lend it meaning, confirming her intention to elevate the status of plant life more broadly. These historical accounts create a context for her work, and reveal a remarkable affinity with the history of ideas. In *The Natural Philosophy of Plant Form*, Arber points out that a recognized part of philosophy aims 'to consider, criticize, appraise, and re-appraise, the work of philosophers of the past; such studies are regarded not as contributions to history merely, but as an intrinsic part of living philosophy' (Fig. 11).[54] Arber suggests that botany could benefit from critical theory, and she offers morphology as a resource. With these words, she vindicates her position as a historian, botanist, and philosopher, rather than an expert. Like Goethe, she criticizes the abundance of specialized scientific fields as a lineage of human authority set forth by empiricism.[55] She criticizes the proliferation of specializations that tend to establish a range of subfields:

> In these days of specialized study, the different branches of biology cannot but lead existences, which are, to a great extent, isolated from one another. The aims, which they pursue, and the highly technical methods by which these aims are achieved, differ so widely that one reminds oneself, with something of a shock, that all the branches are concerned with the same living world.[56]

Arber's philosophy highlights the limits of measurable classification, quantifiable data, simplification, and predictability, a singular perspective that raises awareness of what we can do with plants, rather than what plants are actually doing. In contrast, she contends that morphology relies on what she terms a full understanding of plant life.[57] From Arber's perspective, structure is relational and categories cannot be separated from wholes.

In *The Mind and the Eye: A Study of the Biologist's Standpoint*, Arber does a very 'Latourian' thing: she follows established techniques of science, accepting that scientific proof is a result of academic manipulation.[58] Most remarkably, she broke down what she calls 'the biologist's problem' into five stages that are suggestively detailed in the first half of the publication. In the second half, she attends to the final and sixth stage: contemplation. Her argument is that 'fact' cannot be synthesized since all scientific data is derived from a 'copy' arising from measure.[59] Thus, she describes the *translation* from medium to medium, ultimately describing the reductive vehicle of words, which is the final output scientists depend on to exchange facts.[60] Her contribution to the history of ideas is not unlike Goethe's appreciation that binomial semantics did nothing to further the study of plant life, advancing only human interests. This is an example of how scientific experiments support the publication of words, or more specifically persist through the authority of references.[61] Arber's arguments for a philosophy of plants counter established procedures that reduce the *same living world*, expanding an appreciation of plant life.

Specialization—in Arber's terms—provides crucial metrics for the science community, but does not facilitate a deeper understanding of plants as a philosophical endeavour, a theory worthy of our attention in landscape architecture.[62] The disjunction arises as the profession becomes more and more particular, fragmenting plant life further into a measure of technical expertise. Specialization of parts and a reliance on procedures replaces the plant as a series of dynamic processes, isolating features and attributes alone. This further engenders a reliance on calculation, indexes and accounting, aggregating more parts, at larger scales. Despite a planetary turn and a changing climate, plants remain the backdrop of our human and animal intentions. Can plants ever be reclaimed through formation, creative collaboration, or as a philosophical subject, despite centuries of fixed practices and parts procedures?

Method, theory, design

The three exemplars extracted from the *Live Matter* archive suggest a research agenda that explicates an alternative study in approaching plant life. Understood through the field of morphology, such an inquiry explores the whole plant on the basis of formation theories. Establishing the lineage with Goethe, unity in plant life is advanced through observation, outside of classification. Using experimental models, Darwin strove to explain plant movement using terms that can only be called collaborative and exploratory, expressions that find value in landscape discourse. Arber casts a spotlight on the proper place of morphology in the history of science, by crafting a philosophy of plant life.[63] As these three thinkers concentrate their efforts on observation, aliveness, and philosophy, the plant is revealed as a process. Thus, the methods and histories of plant morphology correspond to the objectives of landscape architecture because the profession is inadequately described if it is limited to fine-tuning binomial indexes, studying desiccated samples, or extending procedures that fragment the plant into useable parts. Plants must be alive to be significant. Aliveness as a point of departure resonates with the ambitions of early plant morphologists, but it still does not account for the absence of morphological influence on the field of landscape architecture.

The potential of thinking differently about plants trespasses on other histories to reveal that botany is not only a science, but also a subject worthy of further creative study (Fig. 12). Exploring the lineage of morphological thought is important to consider because even the contemporary lineage of plant morphology is now hinged on modern systematics, stressing molecular over morphological data:

> Plant morphology is largely a German science that never was prominent in the United States. The German tradition of plant morphology took its origins from the study of the natural history of plants. Because the United States is principally an engineering society, concerned more with the tools of science than with its theory, philosophy, and history, we have never had a comparable natural history tradition. Because it required the use of a particular tool (microscopy), plant anatomy, which focuses on the cell and tissue levels of organization, received greater emphasis and scientific credibility in this country than did plant morphology.[64]

If plants are conceived of as a unique living material, they could resist becoming a tool of science.

Therefore, the subject of *Live Matter* is, in a sense, about how we participate in the universal act of planting. We plant grasslands, forests, coasts, and deserts with plantations, orchards, parks, gardens, and coppices. The specialty of planting—to fix in place—is endowed with distinct technical and cultural meanings that the field of landscape architecture has yet to question. Whether in determining form, representing formation, accepting anti-composition or theorizing about transformation, the speculations embodied in morphology help to rework the assumption that plants are fixed, formal assets of the built environment.

Landscape architecture is a discipline of borrowed consequences, deriving value from a distant horizon, a geological condition, an extreme climate, and adjacent geometry. The practice of transforming the land is indispensably tied to forces external to the design itself. In much the same way, the history of landscape architecture grafts itself to diverse allied disciplines, from agronomy to art, from engineering to ecology. Many practitioners and theorists are diligently articulating an agenda within the built and living environment that makes landscape principles more essential than ever. In this work, we need to re-envision histories as well as futures. Plant morphology and philosophical botany offer the field a rich tradition of scholarship and inquiry. If landscape architects could broaden the perspective from the environmental sciences that accentuate our large-scale ambitions, we could attend to the much smaller scales of transformation implicit in our work. A theory of plant life could remind us that each microscopic fragment culminates in a macrocosmic reading of the subject as a whole.

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