



Symmetry and asymmetry in conceptual and morphological formations

The difference plant body growth can make to human thought¹

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Ontological orientation: Conceptual bodiliness

As a Spinozist philosopher, my working hypothesis is that the concepts with which we think are formed, or *have* form. The colloquial phrase – *a body of thought* – is rendered literal through a Spinozist lens: concepts *are* thought's body. The body that thought is, or that thought has, is not a thing. Rather, it is the always animated typology of active and reactive forces *in* or *as* a concept, when acting as an act of thought.² The concept has, or is, a singular body when it is a thinking-thing-thinking: when it is an idea as it *ideas*.

In *What Is Philosophy?* Deleuze and Guattari state, 'concepts are not made from nothing.'³ What does this imply? It implies that concepts are ontogenetic: that they emerge, change, recede. As primordial bodily mental mutations, they emerge from, and vanish into a non-totalizable, heterotopic⁴ 'zone of productivity . . . a ground of plural becoming'⁵ from the 'primordial asymmetry'⁶ of the infinity of attributes of a single substance. As determined, existent modes, concepts are animated via relational intensities among themselves: that is, they differ. They differ one from the other not in terms of their 'content' or the 'objects' in the world they denote, but rather in terms of their immanent relational intensities; their peculiar active and reactive dynamic typologies as these typologies are enmeshed with others.

Patterning and stabilization

As thought's bodiliness, then, concepts undergo morphogenesis. This takes place at two key sites: at, or in the individual thinking thing that thinks *with* them,⁷ and at or in, the cultural norms of thought and thinking that lives its particular *life of the mind*

in and through this living mesh of ideas. Through morphogenesis, concepts take on patterns. This is clearly evident in human social domains of meaning: the emergence and clumping of concepts into the semi-independent fields of ethics, history, law, geography, medicine, theology, education, botany, economics, art and sexuality, to name but a few. But what is completely overlooked is that this is also true about the shape or form of the concepts themselves. In their emergence, deployment and redeployment, concepts *themselves* 'are concrete assemblages',⁸ come to take on distinct patternings of shape and form: vertical, curvy, linear, radial, dyadic, horizontal, concentric, scattershot, triangular, diagonalist, isometric, spiral, spherical. And, they come to express the concomitant action-operations (and combinations thereof) of these forms and shapes: binarizing, centripetal (exteriorizing), flattening, wobbling, abstracting, flip-flopping, speedy, centrifugal (interiorizing), clambering, hierarching, leaning to one side, accreting, withdrawing, dissipating, equiposed, inefficient, truncating, grounding out, oppositional, unbudgeable.⁹ Moreover, their usage – *thinking* – begins to express upscale discernable patterns or forms: what we sometimes call *styles of thinking*¹⁰ is simply the name for a certain stable typology of active and reactive forces of constellations of concepts in action. Now, because they are heritable, those living geometries of conceptual habits – our *thinking* – tend to give rise, in turn, to those same bodily forms. We are not, as we sometimes like to imagine, independent thinkers with our own unique and groovy style of cognition: we have in fact inherited a narrow repertoire of prefab concepts, and we find ourselves thinking as thinking-things on highly ramified architectonics of ideas, and along deeply grooved paths of thought-action. Finally, we should note that, just as we can say about the periodic table of the elements, certain concepts have come to form large families of practically inert (stable, non-reactive) thought-body forms. And, just like the salts or the inert gases, this family of concepts dominates the field of our thinking-action: the *ways that thought happens*, whether it is *about* ethics, history, law, geography, medicine, theology, education, botany, economics, art or sexuality.¹¹ More than any other, this family of concepts *shapes* our individual and collective thinking. We will return to this claim shortly, with respect to the way that thought and thinking shapes our thinking *about* ethics.

Evolution, deformation, growth

The dominant, legible or 'normal' things to think about; the dominant, legible or 'normal' ways to think-about-things was named by Deleuze and Guattari 'a regime of thought'. The translation of the French term *régime* into the English 'regime' implies that thought and thinking are quasi-military prison houses ruled by strong armed dictators. This does not get it right; it doesn't leave enough space for our basic working claim that 'concepts are ontogenetic. They emerge, change, recede.' Without this latitude, there could be no conversation about ethics; the ethics of thinking. An ethics of thinking involves the almost paradoxical undertaking of shifting the patterns that express one's self as a legible self. How? 'Comment ces régimes de pensées, l'architecture de notre imaginaire fondamentale, le plan de nos concepts de base, sont-ils capables

d'être décolonisées, disassemblées, rassemblées selon un plan différent?¹² And, yet, concepts and the character of conceptual terrains *do* change, grow, deform, evolve. How? Consider three possible ways. They can evolve due to random background mutations – the surprising 'pure becoming'¹³ of concepts: events of thought itself which testify to the ground of plural becoming. Events of 'pure becoming' secure the fact that the appearance of a new form does not automatically entail the disappearance of an old one: one form or operational tendency does not simply take the place of an other, like Pez-mind; rather, a plurality of genuinely different modes of thinking always coexist on the plane of becoming: what varies is the degree of differentiation¹⁴ happening at any given time. Second, concepts can mutate due to exposure events: potent factors conjured or found within the milieu of thinking bodies that are capable of destabilizing them. Third, they can evolve through strategically and continuously applied micro-selection pressures operating via the immanent mechanics of thought (thinking-things-thinking differently) to effect subtle but felt, or sensed shifts in the established patterns of intensities and forces of, or as, thinking. I suspect that this is what the phenomenon we name 'understanding' involves, and feels like, as a lived cognized phenomenon. Also, this latter evolution path is what Deleuze and Guattari have in mind when they say 'concepts must be created'.¹⁵ New concepts can be made, and made by us when adequately and strategically pressured by 'our problems, our history'.¹⁶ Unlike background spontaneous mutation which always maintains a degree of differentiation, within this third domain of concept-making, they identify a special situation: 'concepts can only be replaced by others if there are new problems relative to which it loses all meaning'.¹⁷ In this chapter, I will argue that 'plant ethics' is exactly that: a genuinely new problem relative to which the old concepts, the concepts with which we thought about, and conducted, (human)animal ethics, lose all meaning. Hence, for the question of plant ethics, new ethical concepts need to be created which replace, rather than merely extend or work alongside norms of, and for, animality.

The key point in this section on conceptual morphogenesis is that although concepts and styles of thought *are* conditioned relations and practices – they *are* determinable – and these determinations tend to accrue quasi-stable mechanisms, patterns and tendencies – they *are* also, in principle, always mutable: 'a permanent condition of their existence . . . is an insubordination . . . a certain essential obstinacy . . . a means of escape'.¹⁸ These two facts – the mutability of concepts – the permanent amenability of thinking to an event of thought – and our possible involvement in that mutation – serve as the central axis of this whole chapter.¹⁹ In the next section, we will see how, in some cases – I will focus on the case of posthumanist ethics – concepts and styles of thinking *should* be altered. What we establish in this section is the ontological claim that, as thinking-things-thinking, and as thinking-things-thinking-about-thinking, we are immanent to those very mechanics and forces of thought by which evolution can happen. In short: we are sites of change, growth, mutation, deformation and evolution of thinking, both as individual thinking-things and as systems of thought-norms. We *are* thinking-things. Our concept bodies are affected by, and as thought, but can also affect thought. We can literally *be* thought differently. It is in the nature of ourselves as thinking bodies to enjoy the latent capacity to think-the-difference back into the bodies of those very concepts and the regimes of thought which have become inert, and in

which we participate whether directly or indirectly, intentionally or unintentionally. We have, or perhaps *are*, a capacity to make ‘something new . . . finally come about; to make thinking reach thought’.²⁰ This profound capacity, the capacity to bring about an event of thought, is not sufficiently targeted nor actualized when a given individual undertakes to think-*about-something-differently* (i.e. an intentional, rational shift in the content or target of one’s cogitations or obsessions such as Epicurus or CBT [Cognitive Behavioural Therapy] might advise, a mere change in the objects of one’s ‘wishes’²¹) but rather, by system-wide base-level deformations in the very bodies of thought with which we think: by changing the *form* of the concepts used *to think*, to *imagine*, to *evaluate*, to *understand*, to *wish*. Sustained meditation practice, for instance, has been shown to alter the very speed of reactivity of one’s thinking:²² ‘to reduce the *force* of anger’;²³ that is, to mutate the very suppleness and morph-*ology* of mental-bodies we carry in, and as, wholly and deeply thinking *beings*.

The animal’s body of thought

As I have argued elsewhere,²⁴ *thinking-the-animal* has saturated Western thought. It continues to dominate its images, its stories, its metaphors, its grammars, its logic and all its philosophies. By this, I do not mean that the modern West is obsessed by thinking *about* the animal (though that is also certainly true in the case of *the human animal*): what I mean is that *thinking-as-animal-thinking* has stabilized as the dominant *form* of ratiocination: *how* thought is; how thinking behaves.

The concepts which we – the human animal – have inherited, and with which we think, are strongly marked by an animal form; or, put otherwise, have, and give rise to a pronounced animal bodiliness of thought. The actual fleshed animal body, whether found in the human animal or the panther or the guinea pig, exhibits four stable morphological formal traits (though their admixture varies across species and among individuals): a front and a back, a right and a left side, a top and a bottom, a core and a periphery. Indeed, one way that the kingdom *Animalia* is divided up taxonomically is in terms of arrays of these bodily axes of symmetry. In a parallel fashion, the repertoire of concepts with which we think *about* anything has evolved within this immensely potent animalesque lineage. Put otherwise, all our concepts, no matter the subject domain in which they appear – ethics, history, law, medicine, geography, theology, education, botany, economics, art and sexuality – express a dominant animal bodiliness, both in terms of the forms of the concepts we deploy, and in terms of ideational functions (their concomitant form, or style, of thinking). Whereas in principle, there could be a plurality of forms of thinking-forms and styles, in fact, our concepts are a veritable monoculture of four formal characteristics: right-left bilaterality, a front-to-back split, stable up and downness, and radial concentricity (inside versus outside). We should note that each of these is a dualism. The concomitant thinking styles (of individuals, of entire domains of meaning, and whole cultures) which these dualistic architectures tend to operationalize are either-*judgement* (strict rules for classifying and organizing perceptions of objects), *oppositionality*, linearity, one-to-one object-subject pairing, problem-solvers, ranking, grasping, naming, technocratic forward progress,

results-orientation, efficiency, atomistic individualism, grandiosity and feeling at home in one's world.

My claim about the animalesque nature of thought's body can be corroborated by scrutinizing any modern sociocultural domain. The logic body of late capitalist neoliberalism perhaps offers many examples: the single-mindedness of homogeneous commodity production (Jules: 'What do they call a Big Mac in France?' Vincent: 'A Big Mac's a Big Mac, but they call it Le Big [redacted]');²⁵ the immediacy of consumption and endless deferral of the 'problem of waste [redacted]'; the winner-takes-all global resource extraction game, the craving for innovation over the desire to, as Francis Alys says, 'do more with what we already have',²⁶ an obscene results-driven competitiveness; the categorization of followers as losers; a near-total disregard of the lessons and wisdoms of history; an inability to 'see' ecology (which is a mesh and not a thing that can be 'seen' with the same eyes), a pathological lack of empathy [redacted] Others; the valorization of efficiency; its march-of-progress as necessary narrative [redacted] at every turn. Each of these *difficulties* emanates from an either-or binary logic, and that is the morpho-logic of the animal body, at work, in and as late capitalism, producing the same problem over and over and over again, and merely appearing to offer different solutions to them.

It is interesting (and alarming) to notice just how deeply and consistently gouged our most critical domains are by these same either-or animalesque qualities. A rich example comes from current political theory. We [redacted] an holonic²⁷ thought-body up to the task of responding to anthropogenic climate change.²⁸ For example, 'climate change is conceived of as a problem in need of a solution (as opposed to a condition).'²⁹ A 'condition' is simply not the kind of ontological situation in which one can situate oneself, automatically or unselfconsciously as a subject (the problem-solver), nor name the situation in which one finds oneself as an object (a problem) in need of a solution towards which one *can* innovate.³⁰ Adding another layer to this same issue of impoverished dualistically fixed imaginaries, Biro, drawing on Walter Benjamin, makes the apt observation that [redacted] 'solution response' campaigns – mitigation or adaptation – 'focus on "hardware [redacted] solutions [which] rely on a kind of "homogeneous, empty time", a reification of temporality, drawing on the metaphorical power of what is perhaps the paradigmatic technology of modernity: the ticking clock.'³¹ He points out the inefficacy (and growing tragicomedy) of various urgency-remapping campaigns that have been anchored in a conception of linear time (now [redacted] then and then), with a regular tempo (moving towards it at a calculable, steady rate), and time itself marked by the character of a resource (running out from current amounts). Biro writes: 'The deadline, while conveying a certain political urgency, and clearly useful for the purposes of mobilization, also turns the politics into a situation of absolutes: either we make the deadline or we don't. . . . This way of *thinking about* and practically approaching the issue makes the prospect of what comes after the deadline, in practical terms, unimaginable.'³²

Even in this tiny sliver of (sincere) theorizing about the future of the living planet, one spies the mobilization of a large, functional meshwork of very stable binary axes: problem-solution, subject-object, now-then, us-them.³³ Those are the political imaginaries we have inherited. We *do* have this thought-body and are mobilizing it over and over again by way of response to climate change, to practically no avail.

Undoubtedly, this same body plan dominated the thinking-activity that produced the situation we now call ‘climate change’. Audre Lorde’s oft-repeated warning that ‘we will never dismantle the master’s house with the master’s tools’ takes on a new sense through our analysis: the shape or form of the conceptual tools which built (in this case) the Anthropocene greenhouse cannot be the same mental tools with which we try to live in it or *even think about it*.

The animal body of ethics

Let us now focus on the domain of ethics. As I showed in my recent book,³⁴ ‘contemporary ethics’ is also dominated – in ethical pedagogy, in ethical scholarship and in practical ethical training – by a ubiquitous, deeply oppositional style: Which of the two positions, pro-life or pro-choice, should I take? Is euthanasia for the terminally ill right or wrong? Should I attempt to save the drowning child or not? Should I pull the trolley car lever or not? Are harms reduced or increased by making the survey participant anonymous? Take a stance. Attack the other position with knock-down arguments. *All* the concepts we use to do that thinking *about* ethical phenomena like abortion or the liveability of the planet for future generations of beings – concepts like integrity, dignity, compassion, responsibility, harm, justice, fairness, subjectivity, collectivity, utility – are marked by those same cut-in-half patterns: higher versus lower, in versus out, front versus back, right versus left. While this operation of thought is often effective, appropriate, even at times elegant, as a posthumanist ethical philosopher, my assessment is that this thought-body trait can also be an obstacle to ethicality. It is an obstacle in two closely linked senses.

First, it is an obstacle *when the site of ethicality* – the ethical situation *from* which a call for ethical response emerges for us – is simply not the *kind of object* or question or situation which *bears* the ontological feature of being split or bifurcatable. Timothy Morton has said as much about the nature of the claims climate change makes; Yves Besson argues the same is true about organic agriculture,³⁵ and I have made this argument about unwanted pregnancy. In complex ethical cases, responding with knock normative concepts with their dualistic form and cutting operations is *intentionally* inappropriate. It is like taking a hammer to water. As Biro rightly diagnosed, ‘this *way of thinking about* and practically approaching these sorts of issues’ blocks the ethical imagination from encountering the ethical at issue – that is, actually seeing *what* it is faced with – and hence in this sense is a form or style of conceptualization which is an obstacle for *doing right* by this sort of an object or situation.

Animal ethics

This is precisely what is happening in the sub-area of ethics concerned with the moral standing of ‘the non-human’: animals, plants, bacteria, species, ecosystems; even Gaia herself. Which other *animals* are matters of ethical concern? What, if anything, are they owed, and from whom? What does the good life consist in, or more for

cows, chickens, fish, penguins, panthers, guinea pigs? What, morally speaking, are we permitted, obliged, forbidden to do *with* or *to them*?

These are the sorts of questions asked by *ethically minded human individuals* about other animals. These are the starting block questions which one finds in every single area of animal concern today, theoretical or practical: comparative ethology, government policy in animal shelters, airports, city park by-laws, empirical animal welfare science and theoretical ethics. They might very well be the right questions. However, the concepts deployed, the clinical tests designed in light of these concepts, and the styles of reasoning through the evidence garnered which have *followed* from these questions have actually pushed *the deeply powerful question of the animal* out of reach. This is happening by way of a sort of undercurrent. It looks as if there is a sincere reaching for and caring about animals. For example, thousands of scientists spend umpteen years designing and carrying out experiments to prove that animals suffer *just as we do*. Or cognize *just as we do*. They are operating with a dual epistemic and moral certitude that the suffering or cogitation of any given sentient individual animal is, *just like* the suffering or cognition of individual innocent humans, *and thus* morally pertinent. The above-horizon attempt to reach for and include particular examples of *the non-human animals* within our moral community, to extend moral status to particular demonstrably worthy others like the Great Apes project, needs the presumption and demonstration of similitude, whether biochemical, emotional or sociocultural. However, that similitude *always* moves from an anchored, stable, human-modelled, centre outwards towards others in the moral periphery (*them*) and measures them against the standard we take ourselves to have set. And then, if there is deemed to be adequate resemblance, we must conceptually tow those Others back inside the perimeter of the moral community of equals, thus reifying that very same perimeter. Almost all current moral reasoning *about animals* operates by this gesture of conceptual extension, and yet the more potent undertow of this gesture is that it redeploys a strict boundary, an either-or, an us-them, a human and *non*. As I³⁶ and many others have argued, this gesture not only flattens to a single horizon the immense plurality – the difference – which other forms of life in fact *are* continually excludes other others, thus *replaying* ‘the game’ all over again. Another invisible mechanism is that each time it is *employed*, this entire apparatus recertifies the moral standing of *the human animal* thus, maintaining a background moral hierarchy, despite appearing to be aiming for equality.

Moreover, some theorists have argued that this entire approach is a non-starter because what matters, morally, is not this or that isolated morally relevant feature *in* this or that individual animal, or *in* this or that keystone species, but complex nested holons of eco-relations: chunks of life big enough to continue to *be* alive, in all their complex vitality, a vitality in no way measurable according to some feature of any isolated human individual or a general property said to inhere in the human. Marc Bekoff’s late onset apprehensions even of his prior involvement in the Great Ape Animal Project is telling:

People often ask whether ‘lower’ nonhuman animals such as fish or dogs perform sophisticated patterns of behaviour that are usually associated with ‘higher’

nonhuman primates. . . . In my view, these are misguided questions . . . because animals have to be able to do what they need to do in order to live in their own worlds. . . . I want to reemphasize that the use of the words 'higher' and 'lower' and activities such as line drawing to place different groups of animals 'above' and 'below' others are extremely misleading and fail to take into account the lives and worlds of the animals themselves.³⁷

Even in the sub-domain of ethics known as animal ethics – sites of moral concern that are, after all, very much *like* us – we see a concern arising on the edges of ethical labour over the intellectual appropriateness of deploying the normative repertoire we have inherited: doing 'animal ethics' using animalesque concepts and styles of reasoning is like slicing at water with a hammer.

Plant ethics

Why would an ethicist persist in this vein and try to 'do plant ethics'? There are a number of good reasons. Plants are so crucially important to the health and vitality of all other living beings on this planet that working up some kind of theoretically sound protectorate and deriving a policy of conservation on their behalf by way of that protectorate is prudent. But, if the reason we care about plants (trees, for instance) is because they perform the vital service of making oxygen for us, then the protection need not specify anything more precise than safeguarding a certain minimum amount of CO₂ fixing biomass. From a less crass angle, we might want to defend the view that human-induced plant species loss – biodiversity loss – of orchids, sequoias and grasses is just as egregious as it is for polar bears, tuna and newts, and that if we have a duty to mitigate with respect to the latter, then we also have a duty to mitigate with respect to the former. Yet, another intelligible angle is the possibility that individual plants – trees, grassland communities, potted jade plants – have a kind of dignity and integrity, or can be harmed in some non-trivial way, or enjoy a kind of well-being when cared for, and as such, are as worthy of our moral care and considerability as any comparably complex individual animal creature. This is a view that is expressed in the aesthetic sensibility of the avid gardener and also enshrined in several national constitutions (Switzerland and Ecuador). However, one attempts to angle one's justificatory motivation, it should come as no surprise to hear that the relatively few ethical theorists who have been 'working on plants' admit that granting moral standing to plants remains a difficult endeavor at this stage.³⁸ Any humanist (animal) ethics is really not going to work for plants because plants *really* are not animals.

I said a bit earlier that thinking-with-animal-thinking is an obstacle to ethicality in two senses. The first sense is that it has a mechanism which actually prevents us, as Levinas might say, from being confronted by the ostensible object of ethical concern: the 'irreducible difference between the worldhood of other existences and that of human beings'.³⁹ We saw how that was increasingly true with other-than-human-animals as they looked or acted less and less like us, and if one takes a good hard look

at the plant kingdom, one sees it would be even more true there. Perhaps impossible. 'By considering morphogenic forces embodied in biophysical forms and organic performances of plants, it can be shown that plants exhibit completely original features that make them incommensurable with animals'.⁴⁰ We can never arrive even in the vicinity of the worldhood of plants if we set out equipped with the sorts of ideas that can only orient themselves, and behave, [redacted] an animal body does: 'the animal seems to stand more as a theoretical block than [redacted] useful reference for the moral consideration of plants'.⁴¹

My interest in 'plant ethics' has as its point of departure this very impasse. Although I care very much about plants (possibly more than anyone I know), I am drawn to the work of thinking-about-plants-ethically as a philosopher – that is, for what this work, done differently, might actually accomplish for thinking itself. How might 'plant ethics' cause a mutation in our dominant conceptual habits, given, as we have already established, that such a mutation is sometimes required: 'Because of their literally outstanding nature, plants require a completely new ethical approach'?⁴² The second sense, therefore, in which 'animal ethics' is an obstacle to ethicality is that it is incapable of provoking such a mutation. When we automatically deploy *as* our ethical thoughts, that animal thought-body repertoire of concepts, we miss out on an occasion by which thought itself might *become*. A condition for the creation of concepts is the appearance of a genuinely new problem. The genuine heterogeneity of plant and animal modes of existence means that plant ethics *is* a new problem for ethics and ethical thinking. The inadequacy of animal-based or animal-quality ethics for discovering and grounding our obligation to vegetal life is a unique problem in need of its own concepts. And so, the conferring of moral standing for plants cannot pass with, or through the animal referent, for if it does, it not only misses the mark entirely (plants), but it bypasses the moment or site immanent to the active and reactive force relations that we are, or do, as thinking-things-thinking where there might arise from our (so to speak) *pluripotent ethical-conceptual stem cells* a mutation in ethical thought.

And insofar as the becoming of thought enables us *to respond* more subtly and vitally to the full array of *what is* that p[redacted] itself to us *as* questions of value and meaning, then this becoming of thought [redacted] *completely new approach* – is an ethical event as well. And, if this becoming of thought takes place by way of fully exposing our morally considering selves to planthood as far as possible on its own terms (a sort of vegetal moral pedagogy), then the outcome just might be an ethical event of ethics: the *becoming* of our very 'moral' subjectivity as 'a free, anonymous and nomadic singularity which traverses men as well as plants and animals independently of the matter of their individuation and the forms of their personality'.⁴³ Pouteau spies the same radical potential:

Finally, history seems to be making a feed-back loop: plant domestication was the foundational act of agriculture and moral consideration of plants is now making this foundational act a matter of conscious, cognitive comprehensiveness . . . it is proposed that, as a mirror-image, the moral consideration of plants may involve a mental revolution potentially as paramount as the 'Neolithic revolution'.⁴⁴

Active exposure: Becoming, becoming-plant

'Becoming' is the term Deleuze and Guattari use to name the process by which a primordially differentiating reality enters into compositions and decompositions, giving rise to 'another power'. What is this *other power*? The capacity to mutate; to be or do something other than what one is or does: to *differenciate*. In *A Thousand Plateaus*, Deleuze and Guattari list various becomings: becoming-woman, becoming-child, becoming-animal, becoming-molecular, becoming-imperceptible and becoming-plant. Either these list mere variants on a more fundamental category of becoming, or they are also meant to name *hétérotopiques* becomings: *genuinely other* other-powers given rise to when 'woman' or 'animal' or 'plant' enter into novel compositions. Given the central role that the concept of difference plays in Deleuze and Guattari's thought, it is likely that each of these becomings names a unique capacity.

What would an endeavour to *become* involve? We are instructed as to what it isn't: 'Do not look for a resemblance or analogy.'⁴⁵ *Becoming-dog* does not mean you imitate a dog but 'make your organism enter into composition with something else in such a way that the particles emitted from the aggregate thus composed will be canine as a function of the relation of movement and rest, or of molecular proximity, in which they can enter.' This *something else* 'can be quite varied, and be more or less directly related to the animal in question.'⁴⁶

What, then of becoming-plant? Although Deleuze and Guattari did not elaborate on this mode of becoming, we know what it doesn't involve: we don't literally unite our bodies 'with' a plant or impersonate plants like some sort of photosynthetic circus. Put positively, and in light of the project at hand, we can infer that the *becoming-plant* of our animalesque forms and habits of thought would enter into composition with *something else* – something absolutely different, for instance, plant forms and habits – in such a way that the conceptual or thinking *particles we emit* from that composition would express another power: the singular qualities of *vegetality qua* forms and habits of thought.

The next question, then, is: What are these singular qualities of vegetality? What exactly makes 'plants radically and unconditionally different from animals'?⁴⁷ What is the distinct 'worldhood of plants'⁴⁸ to which we should expose ourselves in order to *become*? I am most interested in what current sciences (botanists, biophysicists, developmental biologists, ecologists) have to say about that based on their systematic, longitudinal assessments of those very questions. And then, bringing those discoveries into direct, productive proximity with philosophy: exposing our concepts (especially our normative concepts) and ways of thinking (especially our valuing) to that other version of being. This is a 'hermeneutic new realism' in the tradition of Goethe and Jakob von Uexküll. It embodies a commitment to 'finding' the significance of plants that does not go by way of an external referent like God or humans – that is, looking for empirical evidence of 'intelligence' or 'capacity for feeling' or 'higher order intentionality' – it passes immediately to the natural forms that are internal to plants; readily on display in plant life itself. This approach reveals the details of the many non-superficial ways that sessile vegetal existence differs from the kingdom *Animalia*.⁴⁹

I wish to now focus the discussion on plant body form: the radically non-animal developmental plans of plants; their cellular and bodily symmetries and asymmetries. In the next section, I will report from scientific findings on plant morphogenesis, noting the uniqueness of this vegetal characteristic by comparison with the same in animal cells and bodies. The point of scavenging from natural science and inserting 'data' into philosophy is neither to reify an empirical approach, nor to eventually 'depart from science but rather to raise science beyond its currently limited scope'.⁵⁰ The *departure* I am interested in is a becoming-plant: not simply by way of informatic description of plant cell growth and morphology that we read here and think *about*, but by way of direct exposure of our thinking *to* what plants are and do. As a Spinozist knows, this doesn't mean we have to stop theorizing and go hang out with the lawn and trees outside. Recall that the vegetal *something* with which we enter into composition does not 'even have to have a localizable relation' to any particular plant or plant kind:⁵¹ it could simply involve an exposure event – mental or physical – to a powerfully strange quality strongly manifested in, or by, plantness: in this case, the peculiar symmetry and asymmetry of plant embodiment. That departure just might be a deterritorialization of our conceptual-thinking animal form as it *becomes vegetal*. A concept is, after all, an act. A new or deformed concept is a different act.

Finally, what is of real interest and value in this new naturalist Deleuzian hermeneutic is the actualization of a latent power *in* and *as* thought – thought itself changing its force patterns; thinking itself expressing *another power*. A becoming-plant of thought is, as I argued above, an ethical event. It is first an ethical event *appropriate to vegetal life*: 'an ethics oriented toward and arising from plants [which] would preclude human self-recognition in and projection onto the world of the flora, or, more positively, would entail an affirmation of the irreducible difference between this world and that of human beings'.⁵² And it is also an ethical event insofar as it is a successful occasion for the emergence and free circulation of the meaningfulness of life itself. 'The power of life, a vital power that cannot be confined within the species, environment or path of a particular diagram. Is not the force that comes from outside a certain idea of life, a certain vitalism?'⁵³

Plant bodies and living: Morphogenesis

Molecular biologists working with plants in a laboratory isolate mutant cell lines, introduce these into living organisms at germination, and track the results through developmental studies: embryogenesis and morphogenesis. The technique of tampering at the level of cells and genes has revealed the presence of extraordinarily complex, multi-level mechanisms in plant development that would not otherwise be apparent. This work has recently raised an entirely new set of questions about the precise relationship between genetic information (coding for protein synthesis and amino acids) and the concrete volumetric orientation living plants must eventually manifest. In the domain of molecular plant biology, the stories about how DNA and RNA determine *which* components will appear and *how much* matter a part or an entity will eventually be comprised of, have been fairly well worked out, but not the stories about *'how the*

spatial expression of these genes is controlled.⁵⁴ What are the spatial ordering occasions, from germination and 'early embryogenesis, stomatal development, and ground tissue formation in the root'?⁵⁵ How do plant cells increasingly differentiate in terms of their symmetries? 'An important and exciting question is why are new axes formed only in lateral organs?'⁵⁶ How do leaves, all of which have a left-right axis, happen when leaves come out of stems and trunks which are always and only cylindrical, that is, have neither left nor right? How exactly is the 3-D, highly stabilized body plan such as 'Old Tjikko, a 9550-year-old Norway Spruce'⁵⁷ exhibits actually *accomplished*?

Spatial mechanics and significance

Plant architecture is currently the 'hottest area of plant developmental biology'.⁵⁸ Mechanistic explanations of organisms are the most common in current biological sciences. 'Mechanism is (in part) the view that to explain the properties of a complex system, one appeals to the causal capacities and relations of its parts.'⁵⁹ In other words, what happens happens due to the powers contained within atomistic self-regulating entities. Current thinking on plant architecture is that the formal elaboration of organisms – their shape – is under genetic control ('patterning genes' and 'transcription cascades'⁶⁰ controlling for the functional protein 'auxin' is where most of the current bets lie⁶¹) and it is just a matter of time before the molecular pathways are mapped. Yet, can we look at this incredible 'natural secret' with fresh eyes and make sense of it with any other thoughts?

All higher plant bodies have only three organs: stem, root and leaf. This body originally develops from a pollinated seed, though it may be propagated by graft or pinning. The human body also begins from a rounded object, the fertilized egg. The first symmetry-breaking development within the embryo, whether animal or vegetal, happens along what is called the apical-basal axis (up-down). This axis, which organizes 'shoot or root fate',⁶² arises in embryogenesis and is the result of the establishment of polarities: a symmetry breaking. But, how these chemical-mechanical polarities even get established in the non-polarized zygote in the first place 'remains enigmatic';⁶³ the 'initiation event' is 'largely unknown'.⁶⁴ The possibility that symmetry breaking gets going inside an organism by virtue of an external cue, possibly an entirely random one, cannot be ruled out. There is evidence that initial polarity in all living beings is formed in response to *external* gradients like the direction of light hitting the earth, or lines of gravity, or metallic gradients associated with the earth's patterns of longitude and latitude, or the location of the ovule relative to the female body in which the ovule is fertilized, or even the angle of entry of sperm (or pollen) into the spherical egg (or ovule).

The most maximally symmetrical object is a sphere: any plane that passes through its midpoint would still preserve its symmetry. Fertilization thus must involve a morphing from a sphere-like object into an elliptically shaped object having an up versus a down.⁶⁵ In the mature plant embryo, there are already distinct zones comprised of a first order cell polarity labelled SAM (the 'shoot apical meristem') and RAM (the 'root apical meristem') which exhibit 'differential sensitivity to auxin transport',⁶⁶ in

other words, levels or zones of 'shoot indeterminacy'⁶⁷ where differentiation (the phenomenon being explained) is already somehow established. Throughout the life of the plant, certain cells are devoted to being 'ranged' along this apical-basal axis – that is, to continuing to reach up while others only ever reach down. The up and downness of plants is maintained or regulated by the stiff plant *cell wall*. The cellular division operation along this first and sustained polarity is one of elongation, establishing in the plant a permanent vertical axis for upwardness and downwardness divided exactly at the horizon of the earth. How is this like or unlike the spatialization of the animal embryo and later body? If the plant protoplasts are isolated from that plant cell, the embryo it develops will again be 'a sphere of tissue' and sensitive to *environmental cues*.⁶⁸ One speculation is that the external cell wall of all plant cells is a descendent of the original external wall of the zygote (like an infinite Moscow doll scaffolding remembering the gesture of the hand that shaped the first one), 'and therefore all plant cells inherit a determinant of outside identity'.⁶⁹ The human, whether in the early embryonic stage or at age 48, also enjoys an up-down axis. Like plants, we elongate along an up-down axis, and maintain that verticality all our lives. However, that verticality comes from deep within us – our spinal cord – rather than from the way that the pliable organ cells on our very outside – the skin – preserve an original 'environmental cue' of directionality.

We also have something like a midpoint, though it is not a point of immobilization, as if up to our waists in concrete or snow. And unlike plants, we aren't constrained to stay in that upward position. Even in an embryo state, we can twist into an L-shape or hang upside-down position. We sleep, swim, bathe, star-gaze, bobsled, fix the car, have sex and die as horizontal beings. We are not sessile and rooted. We are free. Our free motility depends upon, takes advantage of, and habituates in us as our mode of living, the forward-pressing, backward-ignoring adaxial-abaxial plane, the fact that our basality meets and pushes up from the surface of the earth rather than being below it; and the side-to-side swing of our left and our right. This is true from the micro (cellular) to the organismic (body) level: cell migration does not occur in plant embryogenesis whereas it is a key mechanism in animal development. Petrika points out that this makes 'regulated asymmetrical cell division of particular importance to plants'.⁷⁰

The second symmetry development within the embryo, whether animal or vegetal, is radial. Gradients build up between the centre and the periphery (c-p) establishing in the plant a pull of outwardness against a point of inwardness. The overall morphological result is a concentric thickening.⁷¹ A horizontal elongation is not the same as the vertical, however. There must be a greater 'radial than tangential velocity of growth'⁷² towards the outside and a spreading of this thickening along an emerging arc so that the periphery becomes continuously rounded. Indeed, this c-p pathway exhibits a 'cellular pattern which commences with the division of a triangular cell and continues until a complete set of ten different cells, including new triangular cells, is formed among the descendants'.⁷³ Furthermore, while neither of these two primordial axes is determined by the other, the horizontal and vertical must become integrated, coordinated. In other words, two entirely separate and distinct planes of dynamic growth must enter into composition so as to build a wholly integrated 3-D plant body out of cylindrical stems and tapering roots.

Yet – and this is a crucial point – in the upper part of the plant, unlike the animal body, this coordination of symmetries does not lead the plant to have the same inside-outsideness.⁷⁴ Plants face only outward.⁷⁵ Stem and roots have continual cell growth in upward, downward, and outward *directions* (think of the laying down of yearly tree rings). In addition to these cellular actions, though, animals undergo another major shape change early on in embryogenesis. This change called gastrulation⁷⁶ consists in an invagination of the embryo and the creation of an actual space inside: an empty tube. This inner space is in fact an internalization of what was initially facing outward. The inside of animal bodies – mouth cavity, throat, oesophagus, stomach, intestines, anus – is the outside world now hanging through the inside, *as* inside. This mechanism of gastrulation is significant ‘because it gives rise to . . . an actual dualistic state of being’;⁷⁷ whereas plants ‘are un-split beings (having neither inside nor outside),’⁷⁸ i.e., they live as “non-topos” in an undivided, unlimited, non-centered state of being.⁷⁹

The leaves always develop last. An adaxial-abaxial axis (also called dorsal-ventral [dv]) orients a leaf in space front to back such that you could cut a plane right through its thickness from top to bottom and you would get two roughly equal parts: a front and a back. The leaf has a bilateral left-right axis (lr) such that you could fold it in half lengthwise, from tip to stem and you would get two roughly equal pieces: a left side and a right side. And, like the rest of the plant, leaves have an up-down apical-basal axis ordered tip to base such that you could fold it in half widthwise and have a roughly similarly shaped and sized top and bottom. But the leaf organ also has two new axes of symmetry not found elsewhere on the plant. The peculiarly complex spatial development of the leaf challenges the assumption that genes *within the cells* alone encode for these features, in other words, that the development of plant bodies is strictly ‘lineage dependent’. Having a left and a right is *dependent upon* having a front and a back: ‘Proteins encoded by these genes probably function to respond to *positional information* along the adaxial-abaxial axis.’⁸⁰ What the fact of the leaf form tells us is that the way an entity takes up positionality and spatiality is dependent upon other positions and spaces: that the architectures of beings are elaborations of the architectures of other existents. It is hypothesized that this is also true of the incredible array of floral morphologies: that the initiating factor driving the diversification of the shape of flowers were its insect pollinators.⁸¹ These interpretations challenge the basic mechanistic paradigm that ‘to explain the properties of a complex system, one appeals to the causal capacities and relations of its parts.’⁸² What these findings suggest, by contrast, is that to explain the properties of complex systems one has to appeal to the causal capacities and relations of more than what is ‘found inside’ a living being: genes and their mutations; proteins and their functions. Plants thrive only insofar as they are wide open, totally vulnerable to what happens to it. A permanent self-shaping relation to what is alien, other, outside – in this case, to a line of differentiating force – *is* a pronounced feature of vegetal ontology.⁸³

Though the lower part of a plant is dominated by cylindricality, in the mature leaf you won’t find a centre around which a radial pattern spirals. This high up in the vegetal body plan circles and spheres are found in fruiting bodies, seeds and flowers, and in an astonishing geometry of expression,⁸⁴ that is, parts having to do with making another embryo. Finally in some plants, there is a fifth plane: chirality or ‘spiral phyllotaxy’

(sp)⁸⁵ which is a complex of radial, lengthening upward and dorsality whereby branches or leaves or parts of flowers twist up and around. The total number of axes of symmetry any plant can exhibit is five.⁸⁶ Animal bodies can also exhibit all five of these axes. However, the ratio and distribution of these regions differ. While plants, especially angiosperms, are dominated by central-peripheral axis (or radial symmetry) and apicality, or elongation upward and downward, animals, especially mammals, are dominated by the adaxial-abaxial (front-back, anterior-posterior) and left-right planes. And, this leftness and rightness distributed *throughout* the animal body plan: two ears, two kidneys, two gluteus maxima, two big toes, whereas the leftness and rightness of plants are constrained to its extremities. However, perfect bilaterality is not preserved within our extremities: the hand or foot parts of us which also happen to be capable of a degree of activity (being affected in many ways and affecting in many others). A 'opposable thumb' makes our hands the furthest degree of symmetry breaking from the fertilized egg.

This is interestingly true, too, of leaves. In a mature plant leaf, there is actually asymmetry where once there was uniformity: the front and back and asymmetrical, the top and bottom are asymmetrical, and the midpoint outwards are also asymmetrical. So we can say it loses its uniformity and/or asymmetry itself must develop (different than a privation of symmetry). Axes of asymmetry (gradients which do not distribute equally on both sides) must build up.⁸⁷ As both animal and vegetal life develops, it deviates more and more from a simple spatial plan and is able to express a degree of singularity: to become an individual. This singularity (and correlate sensitivity; responsiveness) is a result of increased symmetry breaking – that is, a gradual privation of the initial state of maximum symmetry and stability. Or, to put it in more Deleuzian and positive terms, the individual plant testifies to the fact that vegetal and animal bodies are co-constituted by order and disorder out of, and likely towards, what Primo Levi named the 'primordial asymmetry of all things'.⁸⁸

Conclusion: An open how

It is noteworthy that the oldest living individual things are plants. And that their longevity is of an order of magnitude greater than that found among the oldest living members of animality: tortoises, geoducks, koi, sea urchins, quahogs, ocean sponges and bowhead whales. The longest-living animals are aquatic. Their lives are stuck in water. Plant bodies are even more constrained: stuck in dirt and stuck in one position. But, despite this constraint, the peculiar spatial ontologies of the plant kingdom's development – that all of a plant faces outward, that it really does lack an 'inner life', that it is completely unfree in the earth, that plants' impressive capacity for geometrical morphological variation is wholly dependent on externals – seem to point towards a model of profound vitality, interconnectedness and resilience.

Could we take up that model and express it: *becoming-plant*? Could we figure out a way to make our concepts, our ethical norms, even our bodily sensibilities face only outward, and yet in all directions at once? What productive deformations, for instance, could the concept of justice undergo if we insisted it, too, look in all directions at once?

Could we, tutored by the example of plant bodily being, experience intense positional vulnerability and yet come to know and value ourselves as singular through that very impingement? What would a concept like *act* do, or feel like, if it was absolutely rooted in incapacity, rather than be the fact that turns towards what capacities remain? Could we respond differently in ethically charged situations if our mental and physical propensity for binary action was pushed to the edges of what we do, what we say, and curled like a spiral? Could we live a good life with, and as an ‘indeterminate ontology, [without] clear spatial and temporal boundaries and . . . never be conceived of as complete’?⁸⁹ Could we sense the capacity for immense variation that waits at our extremities rather than in our core, our egos, and develop a new tonal range of virtues that know nothing of our ‘innermost selves’? Could we welcome disorder with gratitude and grace, following the plant’s model of axes destabilizations? To learn to be skillfully and positively affected by random externals, we would need concepts whose own bodily plan and range of action is activated not in a gesture of ‘autonomous choosing’ but in a gesture of exposure.

The giant ethical question that confronts us all, perhaps more now than ever, is, does life even matter? If we prefer to answer yes, then we have some sort of stakes and duty in light of that. This entails that we be ruthless in our assessment of whether our ways of being contribute to, or detract from, the capacity of life *to matter*. One corner of our being to aim that scrutiny is at our forms of thought-being. Does *how* our thinking happens actually contribute to a life of vitality, interconnectedness and resilience? If the answer is no, or even *maybe not*, then we really do need to change our minds.

Notes

- 1 A preliminary version of this essay appeared in French under the title ‘Les Différentes Symétries des Plantes’, in the journal *Chimères* (issue 82, 2014, 165–8) © Éditions érès.
- 2 ‘The concept is an *act* of thought.’ Gilles Deleuze and Félix Guattari, *What Is Philosophy?*, 21. My emphasis.
- 3 *Ibid.*, 19.
- 4 *Hétérotopique* is the term for the non-same primordial character of reality I borrow from Foucault: ‘there is a worse kind of disorder than that of the incongruous . . . I mean the disorder in which a large number of possible orders glitter separately . . . in such a state, things are “laid”, “placed”, “arranged” in sites so very different from one another that it is impossible to find a common place beneath them all’ (Michel Foucault, *The Order of Things*, 48).
- 5 Jay Lampert, ‘Limit, Ground, Judgment . . . Syllogism’, 187–9.
- 6 Primo Levi, *The Black Hole of Auschwitz*, 42.
- 7 ‘Every body, whether human, animal, vegetable or otherwise might have been considered inanimate, has an idea of everything that happens in and to it. This idea constitutes its mind. Every body imagines’ (Spinoza, *Ethics*, Part II, P13 schol). ‘The order of actions and passions of our body is, by nature, at one with the order of actions and passions of the mind’ (*Ibid.* Part III, P2 schol).
- 8 Gilles Deleuze and Félix Guattari, *What Is Philosophy?*, 36.

- 9 This intra-conceptual spatio-temporal character of territories of intelligibility draws directly from Spinoza's understanding of bodies in *The Ethics* Part II, Proposition 13, Lemma 1 through 7 and is intended to connect with Foucault's analysis of 'the diagram', the name he gives to the operation or 'functioning' by which pre-linguistic forces ('statements') take up objects and carve out discursive fields ('spatio-temporal multiplicities' characterized by different forms and layers of modes of power (see Gilles Deleuze, *Foucault*, 34–44).
- 10 This is not dissimilar to what we hear Foucault claiming about the way that power relations take up particular forms and those forms are apparent at all scales of the sociocultural reality: he named these power-patterns 'dispositifs'.
- 11 What Deleuze calls 'hegemonic images of thought' must be similar to what I am assessing here. And Foucault, though he did not speak about regimes of power *in or as* concepts themselves would not have disagreed with this assessment as yet further micro-sites of the operation of 'sovereign regimes of thought'.
- 12 Serge Latouche, *Décoloniser L'imaginaire : La Pensée Créative Contre L'économie de L'absurde*, 23. Italics added. 'How can these regimes of thought, the architecture of our fundamental imaginary, the model of our basic concepts, be decolonized, disassembled, reassembled according to a different plan?' (my translation).
- 13 Gilles Deleuze, *Nietzsche and Philosophy*, 47.
- 14 Gilles Deleuze, *Difference and Repetition*, 209–21.
- 15 Gilles Deleuze and Félix Guattari, *What Is Philosophy?*, 27.
- 16 Ibid.
- 17 Ibid.
- 18 Michel Foucault, 'The Subject and Power', 225.
- 19 As I will argue in the next section, they can and should, in some cases, be altered; and this mutability of thought – the amenability of thinking to an event of thought – is an operation in which we can, and often should, intervene.
- 20 Deleuze, *Foucault*, 119.
- 21 His Holiness the XIV Dalai Lama, *Transforming the Mind*, 4.
- 22 Evan Thompson, 'Contemplative Neuroscience as an Approach to Volitional Consciousness', 187–97.
- 23 His Holiness the XIV Dalai Lama, *Transforming the Mind*, 5.
- 24 Karen Houle, 'Animal, Vegetable, Mineral'.
- 25 *Pulp Fiction* (1994, Miramax), written and directed by Quentin Tarantino.
- 26 *A Story of Deception* (Tate Modern, 2006), p. 12.
- 27 See Arthur Koestler, *Janus*.
- 28 See Timothy Morton, *Hyperobjects*.
- 29 Andrew Biro, 'The Good Life in the Greenhouse?', 36.
- 30 The Existential Analytic (Kierkegaard, Derrida, Heidegger, Levinas) makes similar remarks about grief and death. These are not problems we can solve: they are conditions we must face and endure. Entirely different qualities and kinds of relations are sketched here; different virtues are called out or called for.
- 31 Andrew Biro, 'The Good Life in the Greenhouse?', 36.
- 32 Ibid., my emphasis. Biro introduces from James Howard Kunstler a new concept: 'the long emergency'. This concept can anchor a genuine shift in thinking and thinking-about 'the environment' because it is a nearly, but not quite, unthinkable paradox: something that is urgent (now) *and* something that is slow (not quite now; in a while; coming along). The sense that accompanies this concept is similarly almost nonsensical, but it nevertheless can register as meaningful: the planet needs us to

- do something radical and absolutely fully committed-to now *and* it needs us to be careful, to slow down, to look out onto the longest possible horizon of futurity. Its nearly paradoxical conjunctive form is a better term than ‘deadline’ with which to consider the question of appropriate political tempo since it does not give rise to the defeatist and self-serving disjunct: it’s too late *and* it’s not yet happening.
- 33 Ibid., 20. He notes that many counsel that, in order to make climate change feel like an issue that matters to more people, it has to appear on their ‘emotional radar’, to become ‘ours’ because ‘it means something valuable in their own terms’.
- 34 See Karen Houle, *Complexity, Responsibility, Abortion*.
- 35 Yves Besson, ‘Une histoire d’exigences’.
- 36 See Karen Houle, ‘Infinite, Indifferent Kinship’.
- 37 Marc Bekoff, ‘Animal Rights’, 152.
- 38 Sylvie Pouteau, ‘Providing Grounds’, 154.
- 39 Michael Marder, ‘The Life of Plants’, 260–1.
- 40 Sylvie Pouteau, ‘Providing Grounds’, 154.
- 41 Ibid., 155.
- 42 Ibid., 154.
- 43 Gilles Deleuze, *The Logic of Sense*, 107.
- 44 Sylvie Pouteau, ‘Providing Grounds’, 158. In this article, Pouteau explores what the moral concept of ‘integrity’ might come to mean once it is actually exposed to the complex facticity of vegetal life. It cannot and does not retain a resemblance to the concept of integrity as we apply it to an animal body or animal life.
- 45 Gilles Deleuze and Félix Guattari, *A Thousand Plateaus*, 275.
- 46 Ibid., 274.
- 47 Sylvie Pouteau, ‘Providing Grounds’, 155.
- 48 Michael Marder, ‘The Life of Plants’, 264.
- 49 I have used this approach with plant signalling. See Karen Houle, ‘Devenir Plante’.
- 50 Sylvie Pouteau, ‘Beyond “Second Animals”’, 18–19.
- 51 Gilles Deleuze and Félix Guattari, *A Thousand Plateaus*, 274.
- 52 Michael Marder, ‘The Life of Plants’, 260–1.
- 53 Gilles Deleuze, *Foucault*, 92–3.
- 54 Masao Tasaka, ‘From Central-Peripheral to Adaxial-Abaxial’, 549.
- 55 J. J. Petricka et al., ‘Symmetry Breaking in Plants’, 11.
- 56 Masao Tasaka, ‘From Central-Peripheral to Adaxial-Abaxial’, 548.
- 57 ‘Old Tijikko’.
- 58 Yonghong Wang and Jiayang Li, ‘Molecular Basis of Plant Architecture’, 253.
- 59 Denis M. Walsh, ‘Mechanism, Emergence and Miscibility’, 44.
- 60 See Moriyah Zik and Vivian F. Irish, ‘Flower Development’.
- 61 See John L. Bowman and Sandra K. Floyd, ‘Patterning and Polarity’; Cm. Liu, Zh. Xu and N. H. Chua, ‘Auxin Polar Transport’.
- 62 Masao Tasaka, ‘From Central-Peripheral to Adaxial-Abaxial’, 548.
- 63 A. Hudson, ‘Development of Symmetry in Plants’, 351.
- 64 See Steffen Lau et al., ‘Early Embryogenesis in Flowering Plants’.
- 65 Though I don’t consider it in this chapter, it is also true of flowers. The ancestral form of all flowers was radial symmetry. Evolutionary diversification enabled first a bilateral (l-r) axis, then a dorsal-ventral axis to occur. One of the most ‘striking aspects of flowering plants is the diversity of floral symmetry’ (Lena Hileman, ‘Trends in flower symmetry evolution’, 1648).
- 66 John L. Bowman and Sandra K. Floyd, ‘Patterning and Polarity in Seed Plant Shoots’, 81.

- 67 Yonghong Wang and Jiayang Li, 'Molecular Basis of Plant Architecture', 253.
 68 A. Hudson, 'Development of Symmetry in Plants', 356.
 69 *Ibid.*, 355.
 70 J. J. Petricka et al., 'Symmetry Breaking in Plants', 2.
 71 See T. Laux et al., 'Genetic Regulation'.
 72 D'Arcy Wentworth Thompson, *On Growth and Form*, 279.
 73 P. W. Barlow, H.B. Luck and J. Luck, 'The Natural Philosophy of Plant Form', 1141.
 74 See A. Hudson, 'Development of Symmetry in Plants'.
 75 Sylvie Pouteau, 'Providing Grounds', 156.
 76 Sylvie Pouteau, 'Beyond "Second Animals"', 19.
 77 *Ibid.*
 78 G.W.F. Hegel, *Philosophy of Nature*, 307.
 79 Sylvie Pouteau, 'Beyond "Second Animals"', 20.
 80 Masao Tasaka, 'From Central-Peripheral to Adaxial-Abaxial', 549.
 81 See Wenheng Zhang, Elena M. Kramer and Charles C. Davis, 'Floral Symmetry Genes'.
 82 Denis M. Walsh, 'Mechanism, Emergence and Miscibility', 44.
 83 Epigenetics is corroborating this explanatory shift. See Pilar Cubas, Coral Vincent and Enrico Coen, 'An Epigenetic Mutation'.
 84 See Paul R. Neal, Amots Dafri and Martin Giurfa, 'Floral Symmetry'.
 85 A. Hudson, 'Development of Symmetry in Plants', 349.
 86 Masao Tasaka, 'From Central-Peripheral to Adaxial-Abaxial', 548–550.
 87 A. Hudson, 'Development of Symmetry in Plants', 345–73.
 88 Primo Levi, *The Black Hole of Auschwitz*, 45.
 89 Sylvie Pouteau, 'Providing Grounds', 156.

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